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PROCEEDINGS

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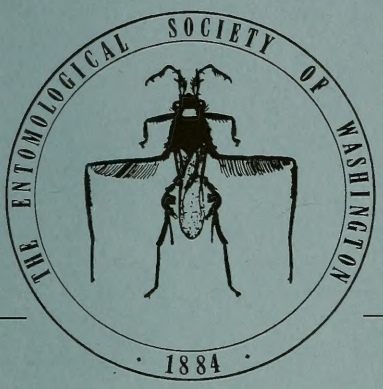

PUBLISHED QUARTERLY

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A PICTORIAL GUIDE TO THE SPECIES OF *ENCARSIA* (HYMENOPTERA: APHELINIDAE) PARASITIC ON WHITEFLIES (HOMOPTERA: ALEYRODIDAE) IN NORTH AMERICA

MICHAEL E. SCHAUFF, GREGORY A. EVANS, AND JOHN M. HERATY

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Abstract.—The 27 species of *Encarsia* (Hymenoptera: Aphelinidae) occurring in North America (including Mexico) and attacking whiteflies (Homoptera: Aleyrodidae) are treated. Each species is keyed and illustrated. A separate diagnosis, list of hosts, and summary of distribution are provided.

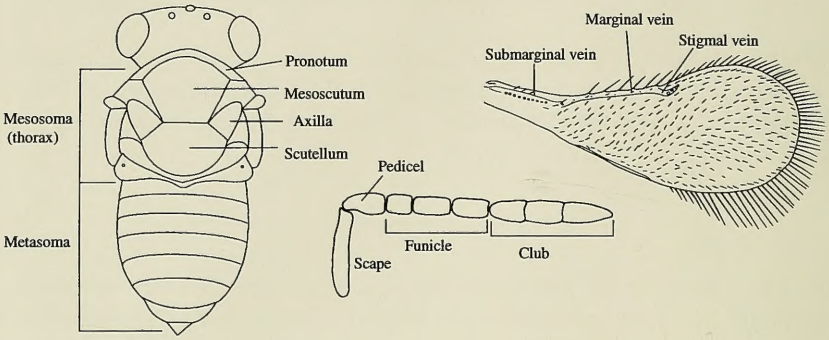
Key Words: Biological Control, Aphelinidae, Aleyrodidae, *Encarsia,* parasite

Various species of whiteflies (Aleyrodidae) are among the most serious of agricultural pests, causing millions of dollars of damage each year to various crops. In 1991, one species (*Bemisia argentifolii* Bellows and Perring) caused damage in excess of $500 million in the U.S. alone (Perring et al. 1993). Among the most common and effective parasitoids of whiteflies are parasitic wasps in the genus *Encarsia* (Hymenoptera: Aphelinidae). These tiny wasps are primary parasites of whitefly species as well as species of scale insects (Coccoidea). Worldwide, over 170 *Encarsia* species have been described (Hayat 1989). In spite of their abundance and usefulness, there are still very few well-illustrated keys and diagnoses, and in North America, no recent identification aids exist. Because of their small size, identification of the various species is difficult under even the best of circumstances and requires the intervention of a specialist in aphelinid taxonomy.

In this paper, we treat the 27 species of *Encarsia* known to occur in North America that are parasitic on whiteflies. It is important, therefore, to be reasonably sure that the species being keyed has been reared from a whitefly and not a scale insect. It is best if parasites are reared from individually segregated whitefly placed in small gel caps or some similar container. Several of these species were imported from various foreign countries into the region in prior biological control programs (e.g. *E. lahorensis,* Nguyen and Sailer 1979; *E. partenopea* (= *E. inaron*), Gould et al. 1992). Importations are continuing against pests such as *Bemisia argentifolii* and at least one species has been recently introduced into the U.S. (*E. lutea,* J. Goolsby, pers. comm.). It is widely recognized that several undescribed species of *Encarsia* are extant in North America and that other species, described from areas such as the Caribbean and Central America, may be present here but have not yet been discovered. This paper represents a starting point from which to continue our discovery and study of this important part of the fauna.

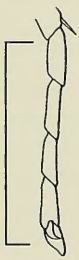
This pictorial key has been designed for non-specialists having limited access to col-

Key to *Encarsia* Parasitic on Whiteflies in North America



1A

Midtarsus
4-segmented



Go to Couplet 2A

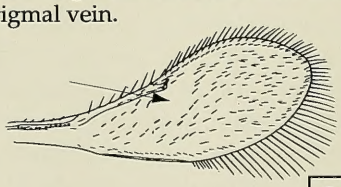
1B

Midtarsus
5-segmented

Go to Couplet 2B

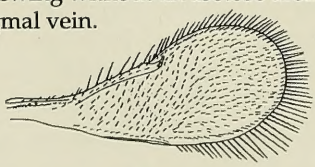
2A

Forewing with an asetose area under stigmal vein.



Go to Couplet 3

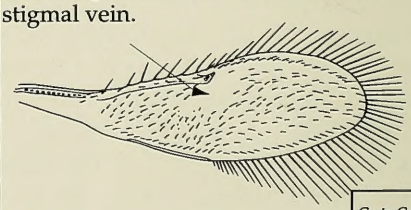
Forewing without an asetose area under stigmal vein.



Go to Couplet 5

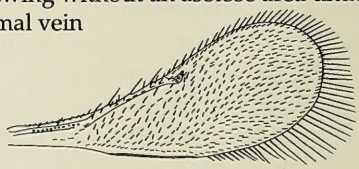
2B

Forewing with an asetose area under stigmal vein.



Go to Couplet 8

Forewing without an asetose area under stigmal vein

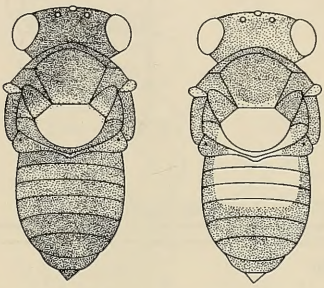


Go to Couplet 10

3A Body mostly yellow except head and anterior thorax.

Encarsia nigricephala Dozier

3B Body mostly dark brown except scutellum and/or median metasoma.

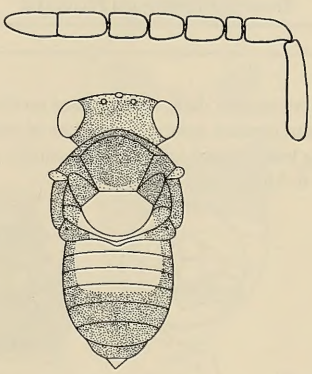


Go to Couplet 4

4A Body mostly dark brown except scutellum; female antenna with F1 about equal to F2.

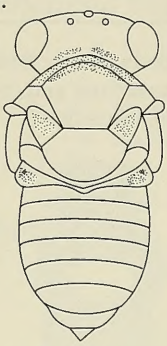
Encarsia quaintancei Howard

4B Body mostly dark brown to brown except median areas of thorax and anterior metasoma; female antenna with F1 about 1/2 length of F2.



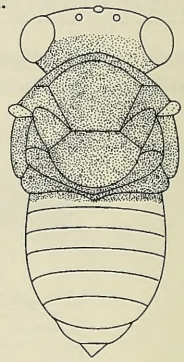
Encarsia cubensis Gahan

5A
Body mostly yellow or orange-yellow.



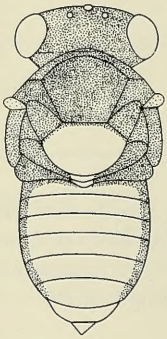
Encarsia meritoria Gahan

5B
Body except metasoma mostly dark.



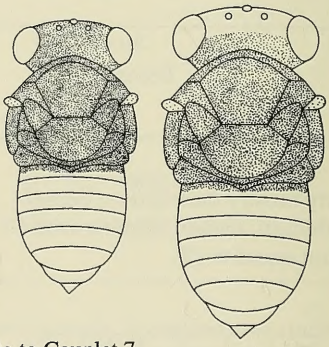
Go to Couplet 6

6A
Scutellum yellow; metasoma laterally dark.



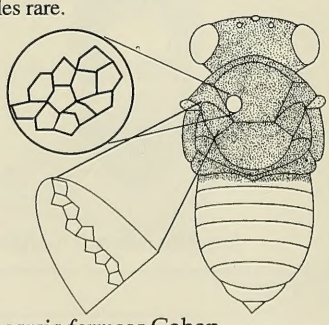
Encarsia variegata Howard

6B
Body except metasoma mostly dark.



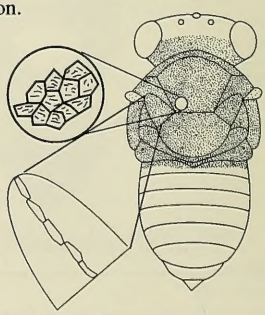
Go to Couplet 7

7A
Occiput usually dark; reticulations on thorax without internal striations; number of cells along longitudinal axis of axilla usually more than 6. Males rare.



Encarsia formosa Gahan

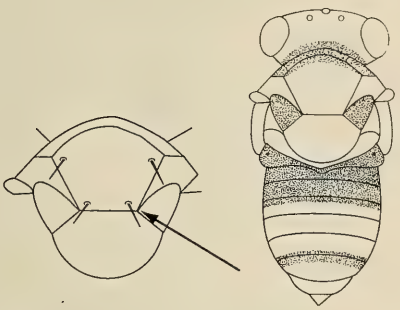
7B
Occiput usually orange hued; reticulations on thorax with internal striations; number of cells along longitudinal axis of axilla usually less than 6. Males common.



Encarsia luteola Howard

8A

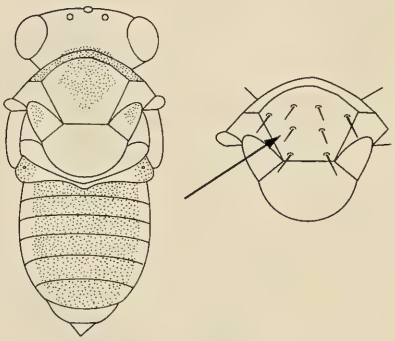
Midlobe of mesoscutum with 2 pairs of setae; metasoma either pale or with at least a pale band medially.



Go to Couplet 9

8B

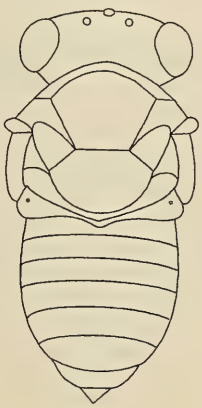
Midlobe of mesoscutum with more than 2 pairs of setae; metasoma mostly dark.



Encarsia pergandiella Howard

9A

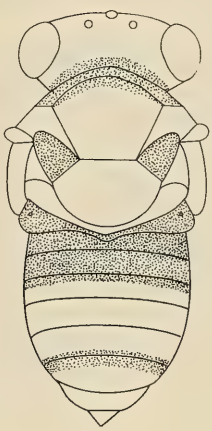
Body almost entirely yellow, there may be some small brown areas ventrally.



Encarsia americana (DeBach & Rose)

9B

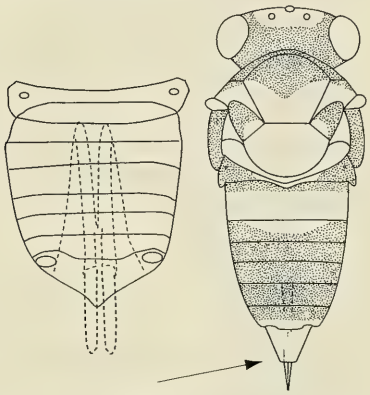
Body with darkened area on anterior thorax, axillae, and anterior and posterior metasoma.



Encarsia basicincta Gahan

10A

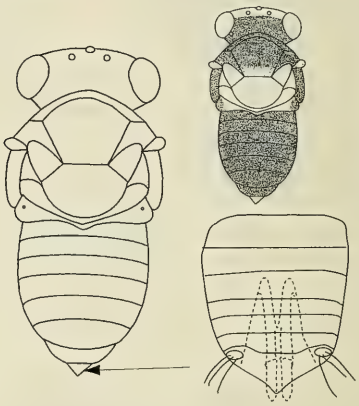
Ovipositor as long as the metasoma and distinctly exserted beyond tip; often covered dorsally by the enlarged last metasomal tergum which is longer than wide. (Note: this character can be difficult to assess accurately. If uncertain, proceed both ways.)



Go to Couplet 11

10B

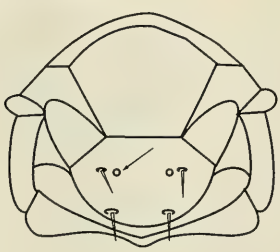
Ovipositor shorter than metasoma; not or only slightly exserted beyond tip; last metasomal tergum not enlarged and wider than long.



Go to Couplet 15

11A

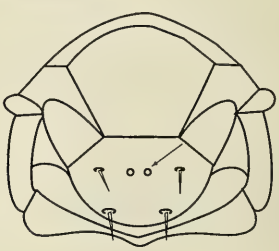
Scutellum with median sensilla separated by more than 2X their own diameter.



Go to Couplet 13

11B

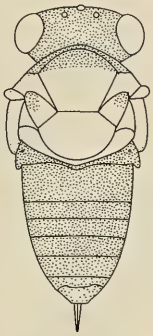
Scutellum with median sensilla close together (less than 2X their own diameter).



Go to Couplet 12

12A

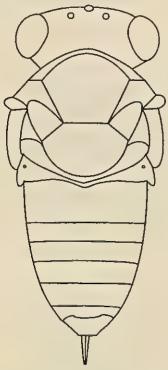
Body mostly dark except for parts of mesoscutum and scutellum yellow



Encarsia portoricensis (Howard)

12B

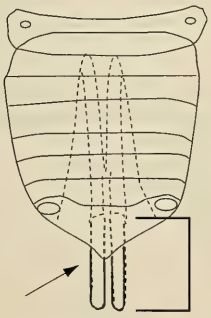
Body uniformly yellow.



Encarsia protransvena Viggiani

13A

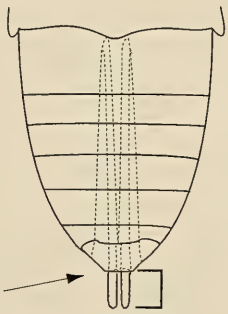
Terminal valve of sheaths 1/2 length of hind tibia.



Encarsia townsendi Howard

13B

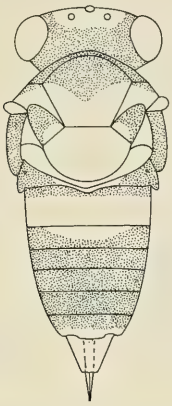
Terminal valve of sheaths less than 1/2 length of hind tibia.



Go to Couplet 14

14A

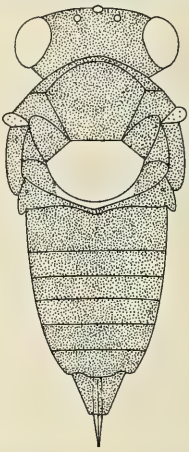
Anterior metasoma and last tergum yellow; much of dorsal mesosoma also yellow.



Encarsia opulenta Silvestri

14B

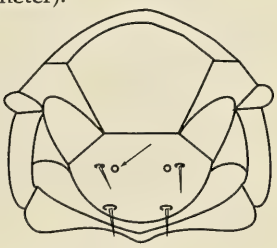
Entire metasoma dark, including last tergum; mesosoma with only scutellum yellow .



Encarsia clypealis (Silvestri)

15A

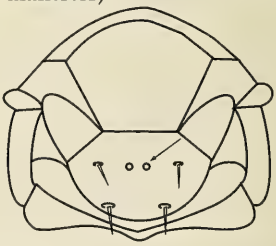
Scutellum with median sensilla far apart (more than 2X their own diameter).



Go to Couplet 19

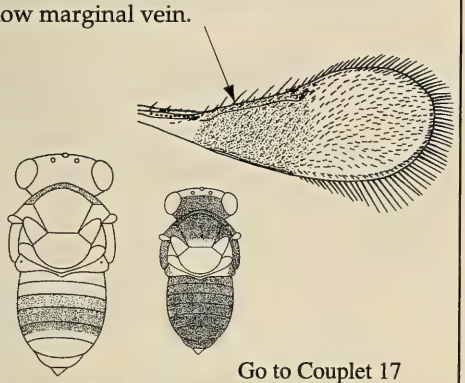
15B

Scutellum with median sensilla close together (less than 2X their own diameter).



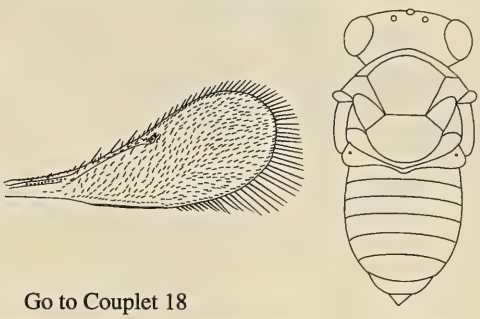
Go to Couplet 16

16A
Body with at least some darkened areas on thorax or metasoma; forewing infuscate below marginal vein.



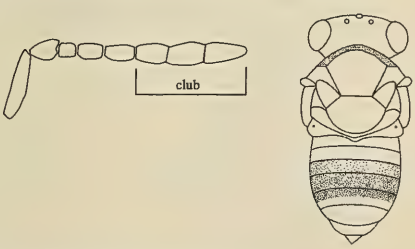
Go to Couplet 17

16B
Body entirely yellow or with only small light-brown areas (*lutea* sometimes with first 2 metasomal terga light brown); forewing hyaline under marginal vein.



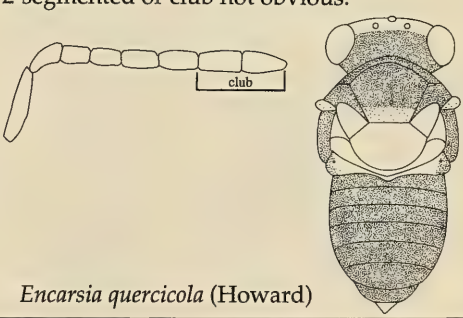
Go to Couplet 18

17A
Color restricted mostly to dark band on metasoma; antennal club 3-segmented.



Encarsia citrella (Howard)

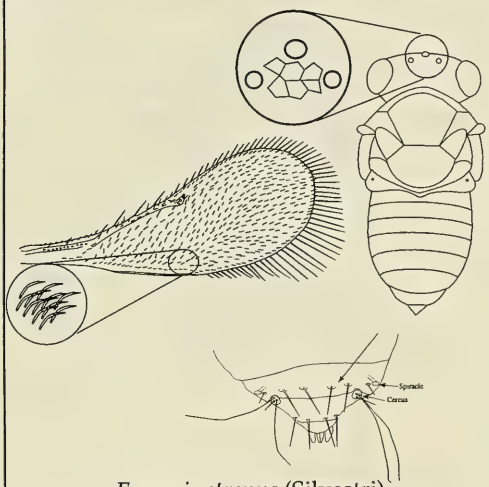
17B
Most of body dark; antennal club 2-segmented or club not obvious.



Encarsia quercicola (Howard)

18A

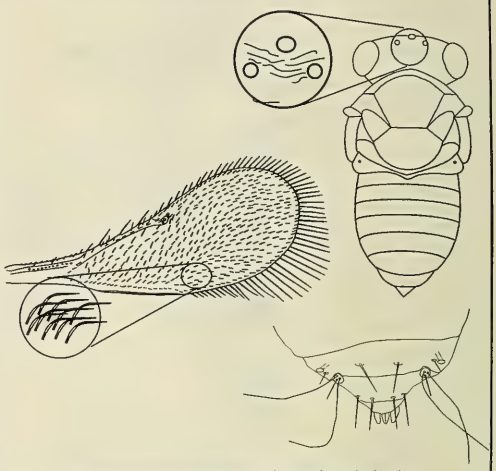
Metasoma with two pair of setae medial to cercus; forewing with normal setae near posterior margin; sculpture between ocelli reticulate.



Encarsia strenua (Silvestri)

18B

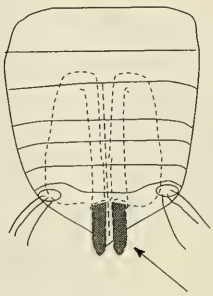
Metasoma with one pairs of setae medial to cercus; forewing with patch of longer, coarse setae near posterior margin; sculpture between ocelli striate.



Encarsia transvena (Timberlake)

19A

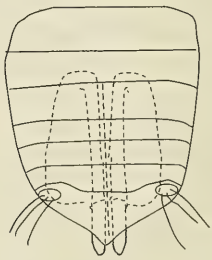
Terminal valvulae of ovipositor dark brown in contrast to yellow color of rest of body.



Encarsia lutea (Masi)

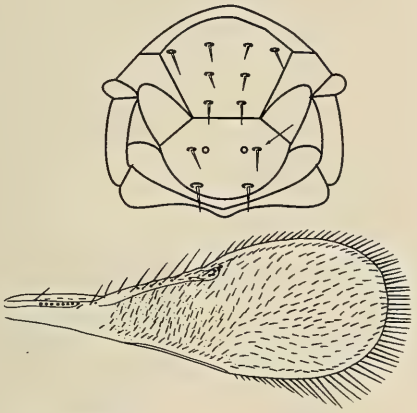
19B

Terminal valvulae of ovipositor same color as rest of body.



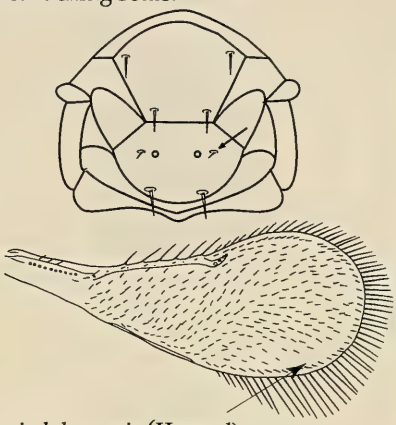
Go to Couplet 20

20A
Mesoscutum with more than 2 pairs of setae; anterior scutellar setae about as large as posterior pair; posterior margin of forewing with scattered setae.



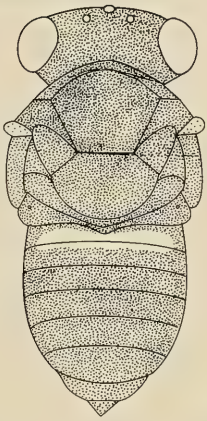
Go to Couplet 21

20B
Mesoscutum with 2 pairs of setae; anterior scutellar setae small, not much longer than width of sensillae, much smaller than posterior pair; posterior margin of forewing with area lacking setae.



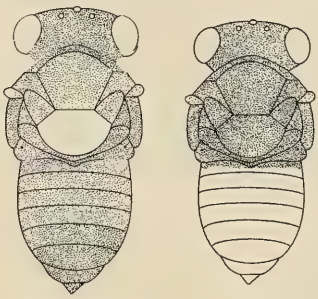
Encarsia lahorensis (Howard)

21A
Entire body dark brown except for small yellow band on anterior metasoma.



Encarsia coquilletti Howard

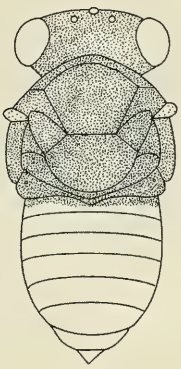
21B
At least scutellum or metasoma and often other parts of body yellow or white.



Go to Couplet 22

22A

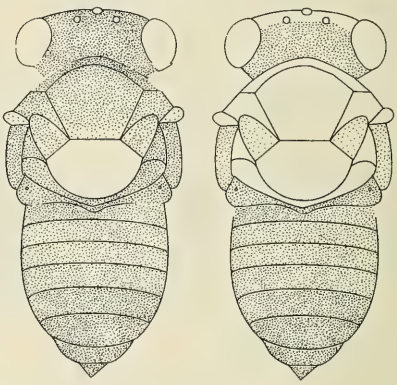
Head and thorax (and anterior margin of metasoma) entirely dark brown, contrasting with yellow metasoma.



Encarsia inaron (Walker)

22B

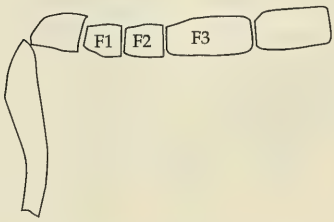
At least scutellum and often posterior margin of mesoscutum and median propodeum yellow; metasoma usually at least partly dark.



Go to Couplet 23

23A

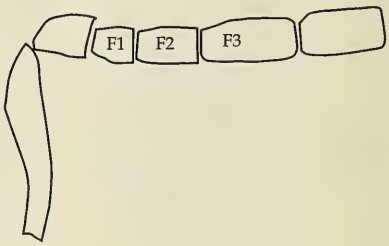
Funicles 1 and 2 small (each only about as long as wide) and together about equal in length to F3.



Encarsia merceti Silvestri

23B

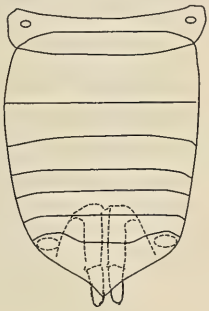
F2 longer than F1, together F1 & F2 noticeably longer than F3.



Go to Couplet 24

24A

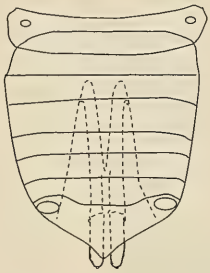
Ovipositor short, only about 1/4 length of metasoma; body black except for scutellum.



Encarsia peltata (Cockerell)

24B

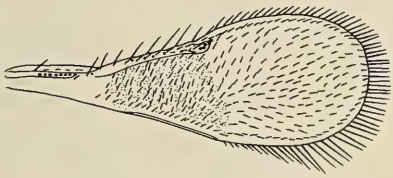
Ovipositor longer, from 1/2 to about equal length of metasoma; body lighter, usually brown except for scutellum or scutellum and surrounding areas of mesosoma.



Go to Couplet 25

25A

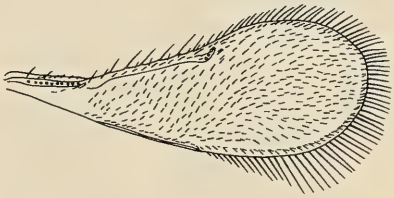
Forewing lightly infuscate below marginal vein; mesoscutum generally orange to whitish and scutellum whitish.



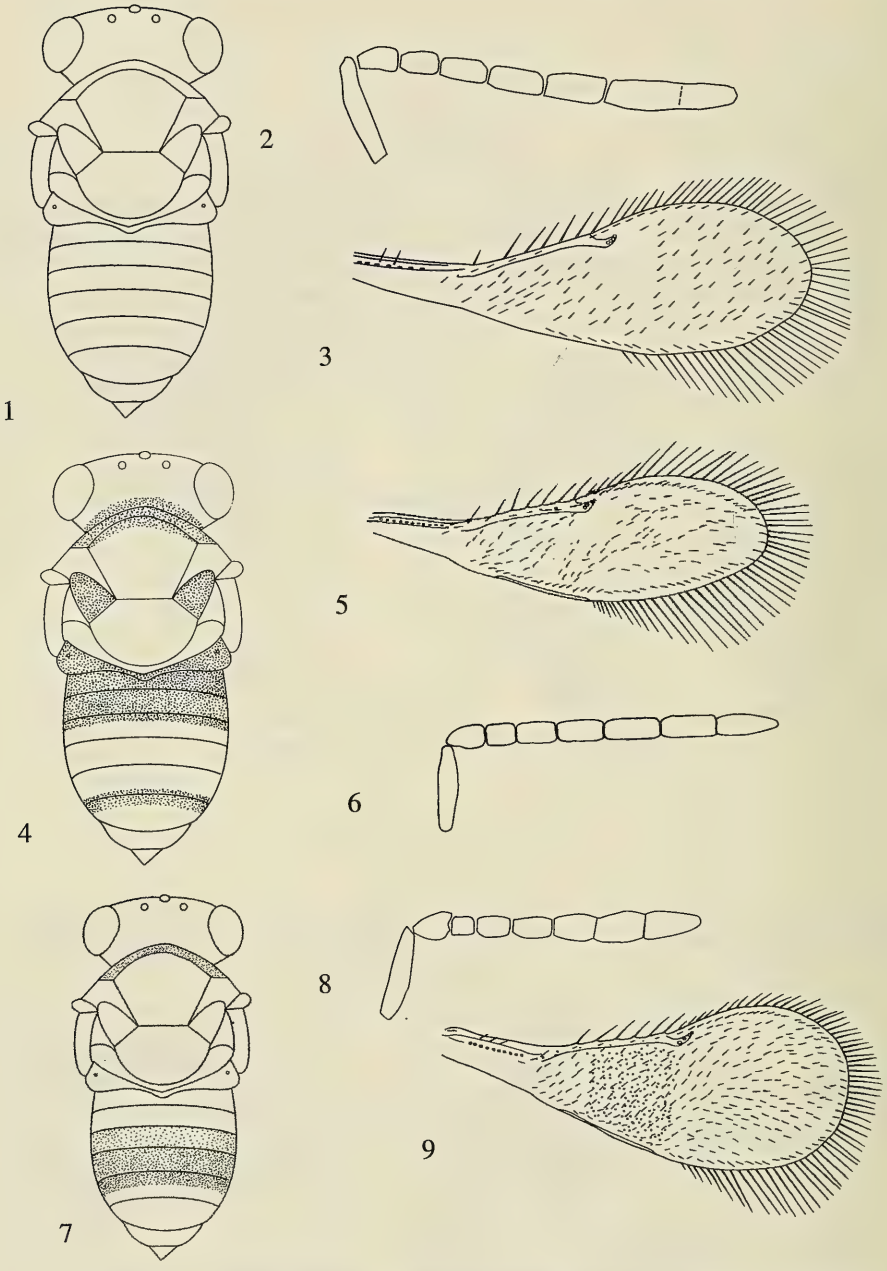
Encarsia smithi (Silvestri)

25B

Forewing hyaline; mesoscutum mostly dark brown except at lateral edges, scutellum white or yellow.



Encarsia divergens (Silvestri)



Figs. 1–9. 1, Habitus, *Encarsia americana.* 2, Female antenna, *E. americana.* 3, Forewing, *E. americana.* 4, Habitus, *E. basicincta.* 5, Forewing, *E. basicincta.* 6, Female antenna, *E. basicincta.* 7, Habitus, *E. citrella.* 8, Female antenna, *E. citrella.* 9, Forewing, *E. citrella.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect body proportions.

lections and literature. It is intended to key out female specimens, but males will sometimes key through the same couplets. Special characters of males are also noted in the species diagnosis. However, given that males are not known for some species, constructing a key for that sex is problematic at this time. Accurate identification of most

species requires use of slide mounted specimens and a compound microscope. The dorsal habitus illustrations have been simplified and somewhat stylized to portray basic information about color patterns. They are not meant accurately to reflect specific characters (e.g. the relative length of the metasoma to the mesosoma). When specific characters are used, separate illustrations are provided. Caution should be used in assessing color patterns since they are known to show variation. We have tried to take this into consideration. While it would be unlikely to find all yellow specimens of a predominantly dark colored species it is more likely that a species portrayed as having only a yellow scutellum might also show light brown coloration on adjoining sclerites. Males, in particular, tend to be more darkly colored than females.

This document is available on diskette in Portable Document Format for Windows and Macintosh from the senior author.

Common names used in the text are from Stoetzel (1989).

Encarsia americana (DeBach and Rose)
(Figs. 1–3)

Aleurodiphilus americanus DeBach and Rose 1981: 660.

Diagnosis: Body mostly yellow (Fig. 1), except for some small ventral brown areas; midtarsus 5-segmented; forewing with asetose area under stigmal vein (Fig. 3); F1 conspicuously shorter than F2 (Fig. 2); mesoscutal midlobe with only 2 pairs of setae (as in Fig. 28). This species is very similar to *basicincta,* which shares the presence of only two pairs of mesoscutal setae. However, *basicincta* has pronounced areas of dark coloration on the metasoma and some color on the pronotum and axillae (Fig. 4). *E. americana* is uniformly yellowish.

This species is most similar to *basicincta* and *pergandiella* (which were also previously placed in *Aleurodiphilus* by DeBach and Rose 1981). It is easily separated from those two species by the almost entirely yellow body (body with dark markings on mesosoma and metasoma in *basicincta* and *pergandiella*).

Hosts: *Aleurothrixus floccosus* (Maskell) (woolly whitefly).

Distribution: U.S. (CA), Mexico. Also recorded from Brazil, Honduras, Puerto Rico, and El Salvador.

Encarsia basicincta Gahan
(Figs. 4–6)

Encarsia basicincta Gahan 1927: 20.

Diagnosis: Body mostly yellow, except for dark-brown band on anterior metasoma and some faint coloration on anterior mesosoma (Fig. 4); midtarsus 5-segmented; forewing narrow, with asetose area adjacent to stigmal vein (Fig. 5), marginal fringe nearly equal in length to width of wing; F1 conspicuously shorter than F2 (Fig. 6). Males unknown.

This species is most similar to *pergandiella* and *americana. E. pergandiella* has an inverted triangular infuscation on the mesoscutum (mesoscutum uniformly yellow except at anterior margin in *basicincta* and wholly yellow in *americana*); metasoma uniformly yellow in *americana* (with anterior brown band in *basicincta*); F1 subequal in length to F2 (F1 noticeably shorter than F2 in *bascicinta* and *americana*); and mesoscutum with more than 2 pairs of setae in *pergandiella* (only 2 pairs in *basicincta*).

Hosts: *Aleurothrixus floccosus* (Maskell) (woolly whitefly), *Tetraleurodes ursorum* (Cockerell).

Distribution: U.S. (FL).

Encarsia citrella (Howard)
(Figs. 7–9)

Prospaltella citrella Howard 1908: 282.

Diagnosis: Body mostly yellow, except for brown stripes on middle of metasoma (Fig. 7); mid tarsus 5-segmented; forewing without asetose area adjacent to stigmal vein and with a lightly infuscate area under marginal vein (Fig. 9); antennal club 3-seg-

mented (Fig. 8); scutellar sensilla only separated about 2× their diameter or less (as in Fig. 70).

This species is quite distinct among the species treated here but might be confused with either *strenua* or *transvena,* both of which, however have mostly yellow bodies and lack any infuscation on the forewing. The brown stripes on the metasoma of *citrella* set it apart from these two species.

Hosts: *Aleuroplatus coronata* (Quaintance); *A. liquidambaris* Russell (cited as *A. elemerae* Mound and Halsey); *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly).

Distribution: US (AZ, CA, FL).

Encarsia clypealis (Silvestri)
(Figs. 10–12)

Prospaltella clypealis Silvestri 1927: 20.

Diagnosis: Body generally brown to dark brown except for scutellum (Fig. 10); midtarsus 5 segmented; forewing without asetose area at stigmal vein (Fig. 11); antenna with F1 quadrate, much shorter than F2 (Fig. 12); ovipositor appearing to be distinctly exserted beyond tip of metasoma; last metasomal tergum as long as wide and dark. This species is most similar to *opulenta,* which also has the ovipositor distinctly exserted beyond the tip of the metasoma. It can be differentiated from *opulenta* by color of the body (much of mesosoma and anterior gaster lightly colored in *opulenta* as well as last metasomal tergum).

Hosts: *Aleurocanthus woglumi* Ashby (citrus blackfly).

Distribution: U.S. (FL), Mexico. Originally described from Vietnam and known from much of southeast Asia.

Encarsia coquilletti Howard
(Figs. 13, 14)

Encarsia coquilletti Howard 1895: 29.

Diagnosis: Body entirely brown to dark brown except for small transverse yellow area on anterior metasoma (Fig. 13); midtarsus 5-segmented; forewing without asetose area at stigmal vein (Fig. 14); ovipositor not obviously exserted beyond tip of metasoma; scutellar sensilla separated more than 2–3× their diameter (as in Figs. 25, 28). This species is fairly distinctive because it is almost entirely dark colored (including the sctuellum). The other species which share most of the characters above have at least either the scutellum or most of the metasoma yellow or white (e.g. *formosa, inaron, luteola*).

Hosts: *Aleyrodes* sp.

Distribution: U.S. (CA, ID, AZ, WA).

Encarsia cubensis Gahan
(Figs. 15–17)

Encarsia cubensis Gahan 1931: 121.

Diagnosis: Body mostly dark colored except scutellum and anteromedian metasoma (Fig. 15); midtarsus 4-segmented; forewing with asetose area around stigmal vein (Fig. 16); F1 of antenna short, less than ½ length of F2 (Fig. 17). This species is most similar to *quaintancei* except that the latter species has a uniformly dark metasoma and F1 of the female antenna is subequal to F2.

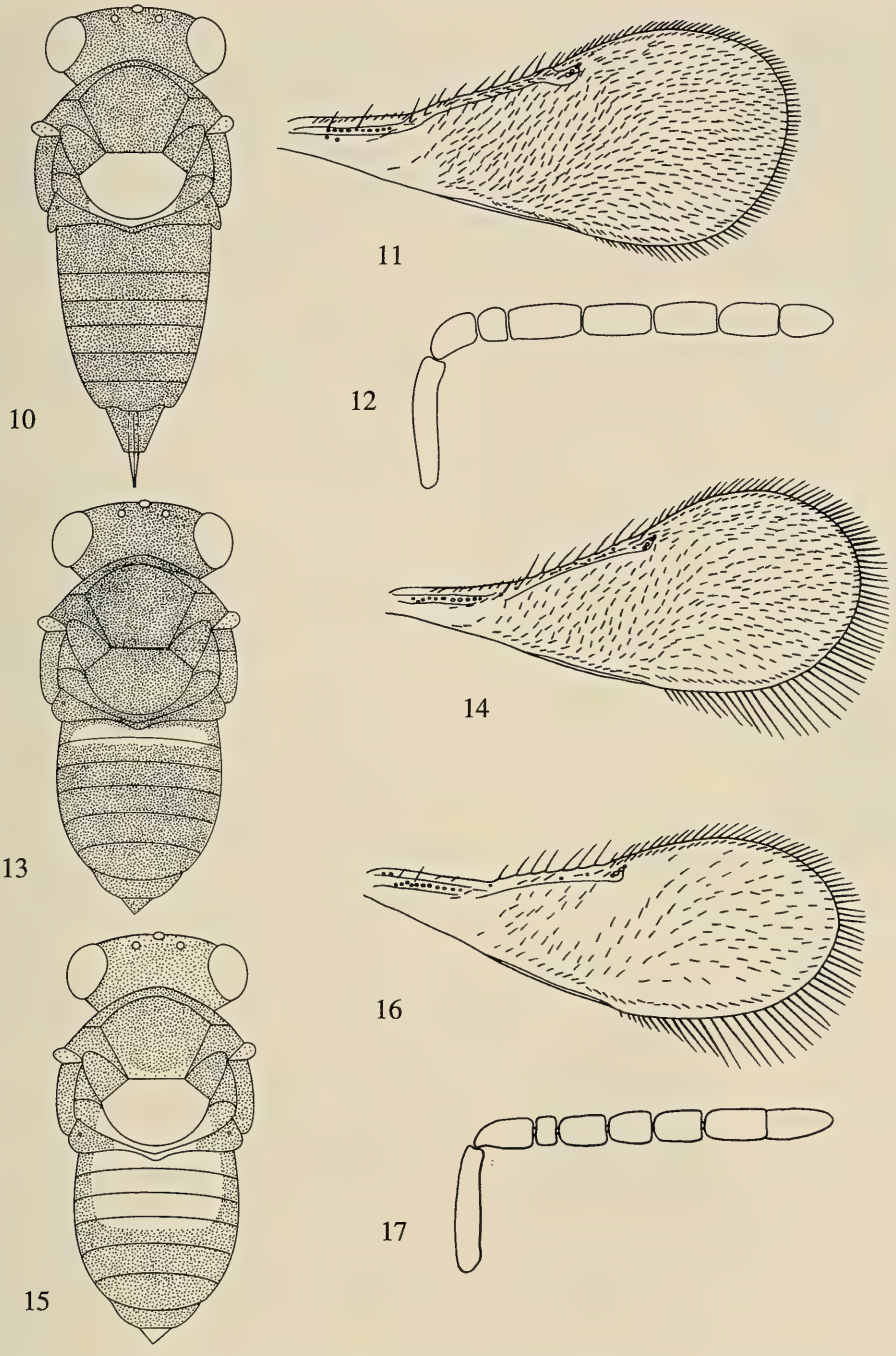
Hosts: *Aleurothrixus floccosus* (Maskell) (woolley whitefly) (also cited as *A. howardi* (Quaintance), a junior synonym).

Distribution: U.S. (FL). Also recorded from the Caribbean and Brazil.

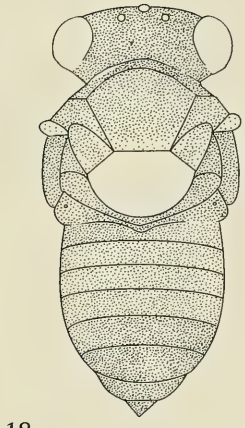
Encarsia divergens (Silvestri)
(Figs. 18–21)

Prospaltella divergens Silvestri 1926: 182.

Diagnosis: Body generally light brown except for the posterior mesoscutum and scutellum, which are orangish or yellow (Fig. 18); midtarsus 5-segmented; forewing hyaline without asetose area at stigmal vein (Fig. 19); ovipositor not obviously exserted beyond tip of metasoma (Fig. 21); scutellar sensilla separated more than 2–3× their diameter (as in Fig. 25); F1 short, F2 about 2.5× as long as F1 (Fig. 20). In some specimens, the midlobe of the mesoscutum is



Figs. 10–17. 10, Habitus, *Encarsia clypealis*. 11, Forewing, *E. clypealis*. 12, Female antenna, *E. clypealis*. 13, Habitus, *E. coquilletti*. 14, Forewing, *E. coquilletti*. 15, Habitus, *E. cubensis*. 16, Forewing, *E. cubensis*. 17, Female antenna, *E. cubensis*. Note: Habitus drawings indicate general coloration patterns and may not accurately reflect body proportions.



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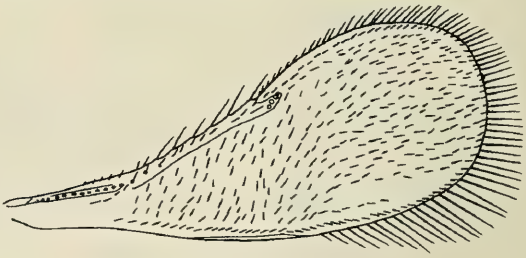

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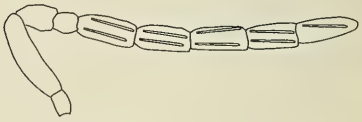

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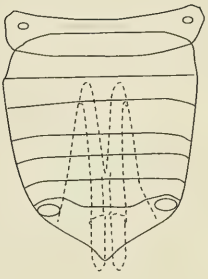

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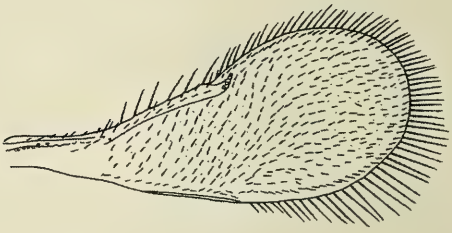

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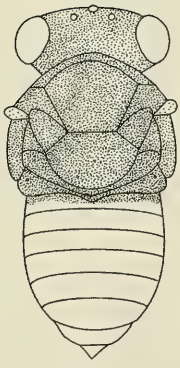

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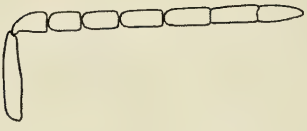

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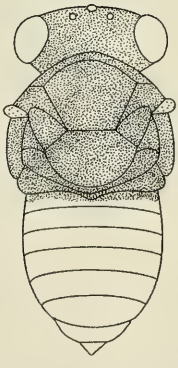

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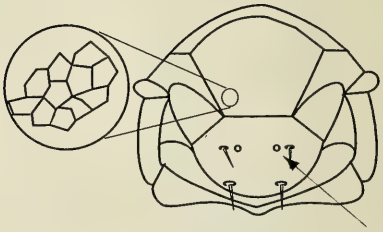


25

Figs. 18–26. 18, Habitus, *Encarsia divergens.* 19, Forewing, *E. divergens.* 20, Female antenna, *E. divergens.* 21, Metasoma, *E. divergens.* 22, Habitus, *E. formosa.* 23, Forewing, *E. formosa.* 24, Female antenna, *E. formosa.* 25, Dorsal mesosoma, *E. formosa.* 26, Habitus, *E. inaron.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect other proportions.

brown, contrasting with the yellow scutellum. This species is very similar to *smithi*. It can be separated from that species by the hyaline front wing (infuscate under venation in *smithi*), the coloration of the metasoma (very dark brown to black in *smithi*) and the relative lengths of F1 to F2 (F2 about 2× as long as F1 in *smithi*).

Hosts: *Aleurocanthus citriperdus* Quaintance and Baker, *A. longispinus* Quaintance and Baker, *A. spiniferus* (Quaintance) (orange spiny whitefly), *A. woglumi* Ashby (citrus blackfly).

Distribution: Mexico, Cuba. Originally described from Indonesia, and also known from India and Singapore.

Encarsia formosa Gahan
(Figs. 22–25)

Encarsia formosa Gahan 1924: 14.

Diagnosis: Head (except antennae) and mesosoma brown to black, metasoma pale yellowish except at anterior edge (Fig. 22); midtarsus 4-segmented; forewing uniformly setose around stigmal vein (Fig. 23); distance between scutellar sensilla greater than 2× their diameter; number of reticulate cells along long axis of axilla usually more than 6; interior of mesoscutal areolae generally without fine striations (Fig. 25); antenna with F1 subequal to F2 (Fig. 24). Males uncommon (this species is usually uniparental); similar to the female, but with the metasoma dark. When present, males are very similar to those of *luteola* except for the following: scutellum dark (pale in *luteola*), funicle about 2.4× as long as wide (only about 2× as long as wide in *luteola*). Like the females, they lack fine striations within the interior of the mesoscutal areolae.

The characters that have been used to differentiate *formosa* and *luteola* have been shown to vary, and it is possible that the two species represent only population differences among one widespread species. However, because no formal synonymy has been published, we have kept the two species separate. There is also some evidence (A. Polaszek, pers. comm.) that males of these two species possess additional character differences (males of *formosa* are rare, but not unknown, unlike *luteola* in which males are common) and this may indicate that there are indeed two species.

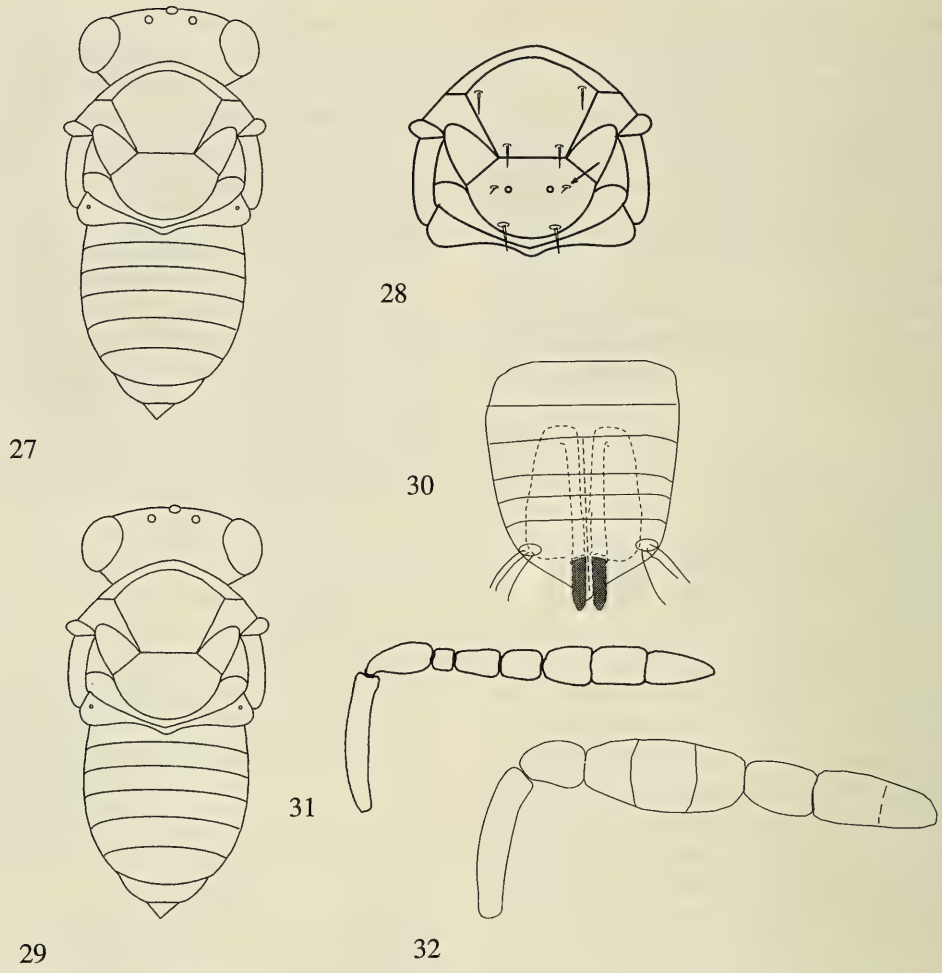
Hosts: *Aleuroglandulus malangae* Russell, *Aleurotrachelus trachoides* (Back), *Aleyrodes lonicerae* Walker, *A. proletella* (L.), *A. spiraeoides* Quaintance, *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly), *Crenidorsum* sp., *Dialeurodes chittendeni* Laing (rhododendron whitefly), *D. citri* (Ashmead) (citrus whitefly), *Tetraleurodes mori* (Quaintance) (mulberry whitefly), *Trialeurodes abutiloneus* (Haldeman) (bandedwinged whitefly), *T. vaporariorum* (Westwood) (greenhouse whitefly), *T. variabilis* (Quaintance).

Distribution: Widespread throughout North America. Has been introduced into many areas of the world for biological control.

Encarsia inaron (Walker)
(Fig. 26)

Aphelinus inaron Walker 1839: 10.
Aphelinus idaeus Walker 1839: 10.
Encarsia partenopea Masi 1909: 32.
Trychaporus aleyrodis Mercet 1930: 196.

Diagnosis: Head and mesosoma dark brown, metasoma yellow (sometimes with light infuscation laterally) (Fig. 26); midtarsus 5-segmented; forewing uniformly setose around stigmal vein (as in Fig. 23); distance between scutellar sensilla greater than 2× their diameter; female antennal club 2-segmented. This species is similar in body color to *formosa* and *luteola* (both with midtarsus 4-segmented) with a light metasoma contrasting with dark head and mesosoma. This color pattern also separates it from other similar species such as *coquilletti* (metasoma mostly dark) and *merceti* or *peltata* (at least scutellum lightly colored).



Figs. 27–32. 27, Habitus, *Encarsia lahorensis.* 28, Dorsal mesosoma, *E. lahorensis.* 29, Habitus, *E. lutea.* 30, Metasoma, *E. lutea.* 31, Female antenna, *E. lutea.* 32, Male antenna, *E. lutea.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect other proportions.

Hosts: *Acaudaleyrodes citri* (Priesner and Hosny), *Aleyrodes lonicerae* Walker, *A. proletella, A. singularis* Danzig, *Asterobemisia carpini* (Koch), *A. paveli* (Zahradnik), *Bemisia argentifolii* (sweetpotato whitefly) (formerly *B. tabaci* (Bellows et al. 1994), *Bemisia* sp., *Bulgarialeurodes cotesii* (Maskell), *Siphoninus immaculatus* (Heeger), *S. phillyreae* (Haliday), *Trialeurodes vaporariorum* (Westwood) (greenhouse whitefly).

Distribution: U.S. (CA, FL), introduced. Europe, Africa, Asia.

Encarsia lahorensis (Howard)
(Figs. 27, 28)

Prospaltella lahorensis Howard 1911: 132.

Diagnosis: Body uniformly yellow (Fig. 27); midtarsus 5-segmented; forewing without asetose area under stigmal vein; mesoscutum with 2 pairs of setae (Fig. 28); scutellar sensilla separated more than 2× their diameter, setae laterad of sensilla reduced. This species is distinctive because of the reduced anterior scutellar setae, but might be confused with *strenua* or *transvena*

which are also uniformly yellow. However, those two species have the scutellar sensilla close together and the setae laterad of the sensilla are of normal size.

Hosts: *Aleurodicus dispersus* Russell, *Dialeurodes citri* (Ashmead) (citrus whitefly), *D. citrifolii* (Morgan) (cloudywinged whitefly), *D. kirkaldyi* (Kotinsky) (Kirkaldy whitefly). Also possibly a parasite of *Trialeurodes ricini* (Misra).

Distribution: U.S. (AL, AR, CA, FL, GA, LA, MS, NC, SC, TX). Also recorded from India, Israel, Italy, and Pakistan.

Encarsia lutea (Masi)
(Figs. 29–32)

Prospaltella lutea Masi 1909: 25.

Diagnosis: Body uniformly yellow except for black terminal valvulae (Fig. 30); midtarsus 5-segmented; forewing without asetose area around stigmal vein; scutellar sensilla separated more than 2× their diameter; F1 quadrate and shorter than F2 (Fig. 31); ovipositor about half length of metasoma, third valvulae (terminal sheaths) dark in contrast to rest of body. The distinct coloration of the terminal valvulae sets this species apart from all others in North America.

Males of *E. lutea* have the first 3 funicular segments enlarged and club-like (Fig. 32).

Hosts: This species is very polyphagous and has been recorded from a large number of hosts including *Acuadaleyrodes citri* (Preisner and Hosny), *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly), and *Trialeurodes vaporariorum* (Westwood) (greenhouse whitefly).

Distribution: U.S. (TX). Recorded from most other regions of the world.

Notes: *E. lutea* was released for the first time in the U.S. in Texas in 1995 (J. Goolsby, pers. comm.).

Encarsia luteola Howard
(Figs. 33, 34)

Encarsia luteola Howard 1895: 29.
Encarsia angelica Howard 1895: 30.
Encarsia deserti Gerling and Rivnay 1984: 439.

Diagnosis: Head with occiput dark orange, rest of head (except antennae) and mesosoma dark brown to black, metasoma pale yellowish (Fig. 33); midtarsus 4-segmented; forewing uniformly setose around stigmal vein; distance between scutellar sensilla greater than 2× their diameter; interior of mesoscutal areolae with fine striations (Fig. 34). Males common (this species is usually biparental). Similar to the female, but with the scutellum pale. Males are very similar to those of *formosa* except with funicles about 2.0× as long as wide (about 2.4× as long as wide in *formosa*). Like the females, they have fine striations within the interior of the mesoscutal areolae.

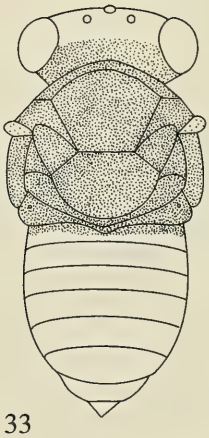
Hosts: *Aleyrodes* sp., *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly), *Dialeurodes* sp., *Aleurocybotus occiduus* Russell, *Trialeurodes abutiloneus* (Haldeman) (bandedwinged whitefly), *T. ferrnaldi* (Morill), *T. packardi* (Morill) (strawberry whitefly), *T. vaporariorum* (Westwood) (greenhouse whitefly), *T. variabilis* (Quaintance).

Distribution: U.S. (AZ, CA, CT, FL, MS, PA, DC). Also occurs in Central and South America and has been introduced into Israel.

Encarsia merceti Silvestri
(Figs. 35–38)

Encarsia merceti Silvestri 1926: 187.

Diagnosis: Body mostly dark brown except yellow on vertex, scutellum (Fig. 35), and occasionally posterior mesoscutum; midtarsus 5-segmented; forewing without asetose area under stigmal vein, infuscate under marginal vein (Fig. 36); scutellar sensilla separated by more than 2× their own diameter; antenna with F1 and F2 small (quadrate) (Fig. 37); combined approximately equalling length of F3. This species is similar to *smithi* from which it may be



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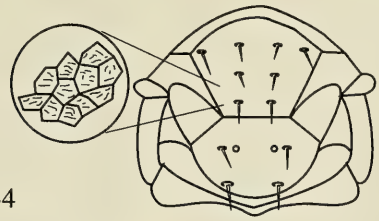

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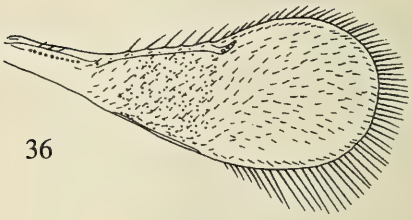

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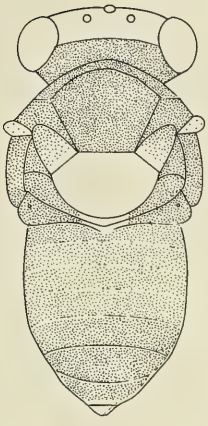

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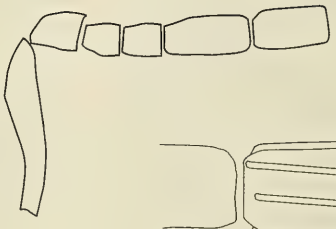

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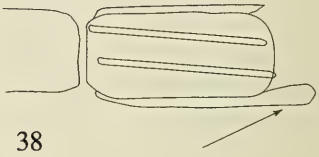

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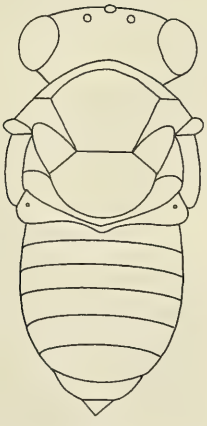

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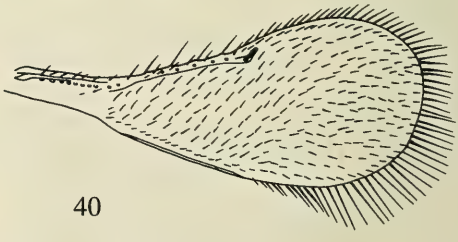

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Figs. 33–40. 33, Habitus, *Encarsia luteola.* 34, Dorsal mesosoma, *E. luteola.* 35, Habitus, *E. merceti.* 36, Forewing, *E. merceti.* 37, Anterior portion of female antenna, *E. merceti.* 38, First funicular segment of male, *E. merceti.* 39, Habitus, *E. meritoria.* 40, Forewing, *E. meritoria.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect other proportions.

separated by the length of F2 (F2 about 2X as long as F1 in *smithi* and F1 and F2 about equal in *merceti*). *E. merceti* might also be confused with *peltata* which is also mostly dark bodied. However, the forewing of *peltata* shows no infuscation under the marginal vein and does not have the smaller quadrate F1 and F2 present in *merceti.*

Males of *E. merceti* have a distinctive enlarged sensillum on the first funicular segment that extends, balloon-like, from the end of the segment (Fig. 38).

Hosts: *Aleurocanthus citriperdus* Quaintance and Baker, *A. spiniferus* (Quaintance), *A. woglumi* Ashby (citrus blackfly).

Distribution: Mexico, Cuba, Asia.

Encarsia meritoria Gahan
(Figs. 39, 40)

Encarsia meritoria Gahan 1927: 19.
Encarsia hispida DeSantis 1948: 45.

Diagnosis: Body uniformly orange or orange yellow (Fig. 39); midtarsus 4-segmented; forewing uniformly setose around stigmal vein (Fig. 40); distance between scutellar sensilla greater than 2× their diameter (as in Fig. 25). Among the group of species with 4-segmented midtarsi and no asetose area under the stigmal vein, *meritoria* is the only one that is mostly yellow bodied. The others (*variegata, formosa, luteola*) have extensive areas of the mesosoma brown to dark brown.

Hosts: *Aleuroglandulus malangae* Russell, *Aleurothrixus porteri* Quaintance and Baker, *Aleyrodes spiraeoides* Quaintance, *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly), *Dialeurodes* sp., *Siphoninus phillyreae* Haliday, *Tetraleurodes acaciae* (Quaintance), *Trialeurodes abutiloneus* (Haldeman) (bandedwinged whitefly), *T. floridensis* (Quaintance) (avocado whitefly), *T. vaporariorum* (Westwood) (greenhouse whitefly), *T. variabilis* (Quaintance).

Distribution: U.S. (CA, FL). Also occurs in Mexico and Central and South America.

Notes: *Encarsia hispida* was first synoymized with *meritoria* by Viggiani (1989) and then resurrected by Polaszek et al. (1992). We now believe that the original synonymization was correct and have combined the two names.

Encarsia nigricephala Dozier
(Figs. 41–44)

Encarsia nigricephala Dozier 1937: 129.

Diagnosis: Head and anterior mesoscutum dark brown (Fig. 41), rest of body yellow; midtarsus 4-segmented; F1 shorter than pedicel and club 3-segmented (Fig. 42); forewing with asetose area under stigmal vein (Fig. 43); mesoscutum with 2 pairs of setae (Fig. 44); distance between scutellar sensilla more than 2× diameter of sensilla. The dark head and anterior mesoscutum contrasting with the pale color of the rest of the body in combination with the 4-segmented midtarsi and asetose area on the forewing, make the female readily recognizable from other *Encarsia* species.

Males have the 1st and 2nd funicular segments enlarged and with large rounded sensilla. Likewise, the strangely swollen 1st and 2nd funicles of the male make it readily recognizable (male *quaintancei* also have F1 and F2 enlarged, but that species has 3–4 pairs of mesoscutal setae and male *lutea* have the first 3 funicles enlarged).

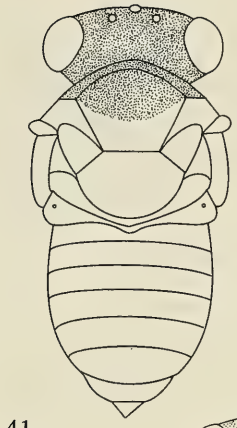
Hosts: *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly); *Trialeurodes abutiloneus* (Haldeman) (bandedwinged whitefly), *T. floridensis* (Quaintance) (avocado whitefly), *T. vaporariorum* (Westwood) (greenhouse whitefly).

Distribution: U.S. (FL, GA, TX). Also widespread in Mexico and Central and South America.

Encarsia opulenta Silvestri
(Fig. 45)

Encarsia opulenta Silvestri 1928: 30.

Diagnosis: Area around ocelli, posterior mesoscutum, scutellum, anterior and pos-



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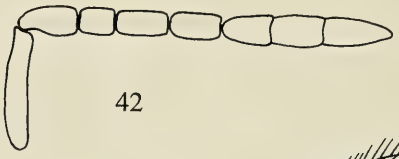

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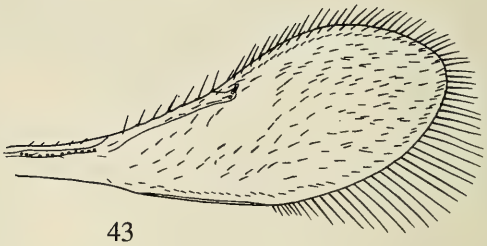

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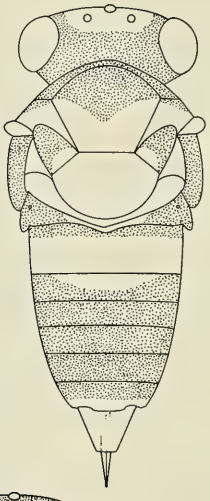

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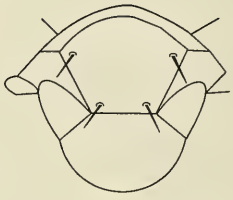

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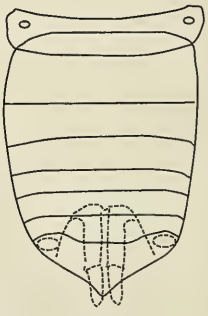

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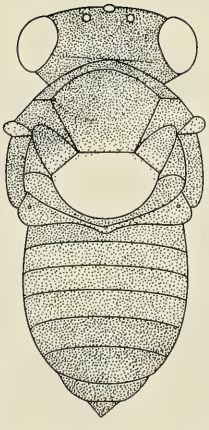

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Figs. 41–48. 41, Habitus, *Encarsia nigricephala.* 42, Female antenna, *E. nigricephala.* 43, Forewing, *E. nigricephala.* 44, Dorsal mesosoma, *E. nigricephala.* 45, Habitus, *E. opulenta.* 46, Habitus, *E. peltata.* 47, Female antenna, *E. peltata.* 48, Metasoma, *E. peltata.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect body proportions.

terior tip of metasoma yellow, rest of body brown (Fig. 45); midtarsus 5-segmented; forewing uniformly setose around stigmal vein; distance between scutellar sensilla greater than 2× their diameter (as in Fig. 25); ovipositor appearing distinctly exserted, last metasomal tergite as long as wide. This species is most similar to *clypealis* which shares the elongated last gastral tergum and ovipositor appearing exserted. However, *clypealis* differs from *opulenta* in being almost uniformly dark colored except for the yellow scutellum (Fig. 10).

Hosts: *Aleurocanthis citriperdus* Quaintance and Baker, *A. spiniferus* (Quaintance), *A. woglumi* Ashby (citrus blackfly).

Distribution: U.S. (FL, TX), Mexico, Cuba. Also Asia, Pakistan.

Encarsia peltata (Cockerell)
(Figs. 46–48)

Mimatomus peltatus Cockerell 1911: 464.

Diagnosis: Body dark brown to black with yellow scutellum (Fig. 46); midtarsus 5-segmented; forewing without asetose area under stigmal vein; antenna with F2 longer than F1 (Fig. 47); scutellar sensilla separated by more than 2× their own diameter and scutellum with 2 pairs of equal sized setae (as in Fig. 25); ovipositor short, less than ⅓ length of metasoma (Fig. 48). This species is similar to *merceti, townsendi,* and *divergens.* It is unusual in that it has a very short ovipositor compared to the other species (ovipositor usually at least half as long as metasoma and often as long as metasoma). Also, in most of the other species other parts of the mesosoma beside the scutellum are lighter colored than the surrounding dark areas.

Hosts: *Aleyrodes pruniosus* Bemis (cited as *A. pruinosa euphorbianum* Cockerell).

Distribution: U.S. (CA).

Encarsia pergandiella Howard
(Figs. 49–51)

Encarsia pergandiella Howard 1907: 78.
Encarsia versicolor Girault 1908: 53.
Encarsia bemisiae DeSantis 1981: 37.
Encarsia tabacivora Viggiani 1985: 82 (as replacement name for *bemisiae* DeSantis).

Diagnosis: Body largely yellow except for pronotum, inverted triangular brown spot in central mesonotum and larger area on metasoma (Fig. 49); midtarsus 5-segmented; forewing narrow, with asetose area adjacent to stigmal vein (Fig. 51), marginal fringe about ½ wing width and membrane of wing generally lightly infuscated beneath venation; F1 about equal in length to F2 (Fig. 50). Males similar to females, with triangular mesonotal spot usually more heavily infuscated and axillae and metasoma dark brown. This species is most similar to *basicincta.* In that species, there is no triangular spot on the mesonotum (mesonotum uniformly yellow), and F1 is shorter than F2. Males of *basicincta* are unknown.

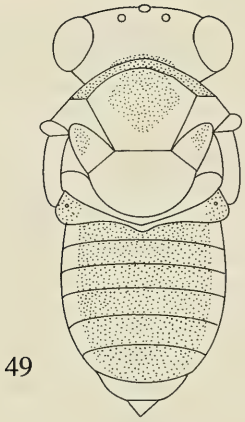
Hosts: *Aleyrodes* sp., *Aleurodicus dispersus* Russell, *Aleuroglandulus malangae* Russell, *Aleuroplatus coronata* (Back), *A. elemerae* Mound and Halsey, *Aleurothrixus floccosus* (Maskell) (woolly whitefly), *Aleurotrachelus trachoides* (Quaintance), *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly), *Dialeurodes citri* (Ashmead) (citrus whitefly), *D. kirkaldyi* (Kotinsky) (Kirkaldy whitefly), *Trialeuordes abutiloneus* (Haldeman) (banded-winged whitefly), *T. floridensis* (Quaintance) (avocado whitefly), *T. vaporariorum* (Westwood) (greenhouse whitefly), *T. variabilis* (Quaintance).

Distribution: U.S. (CA, DC, FL, GA, IL, MA, NY, PA, SC, TX). Also occurs in Mexico, most of Central and South America, and has been introduced into Italy.

Encarsia portoricensis Howard
(Fig. 52)

Encarsia portoricensis Howard 1907: 77.

Diagnosis: Body with head orange brown, pronotum, anterior mesocutum, anterior axillae, propodeum and metasoma



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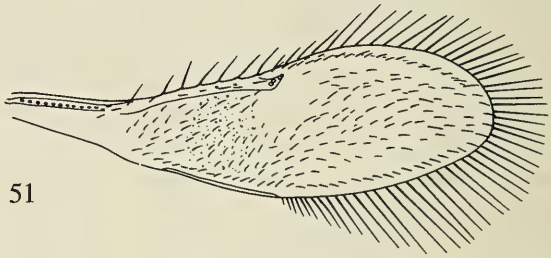

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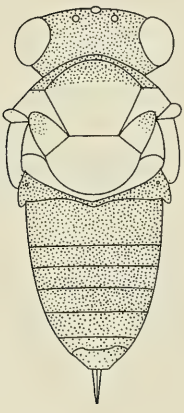

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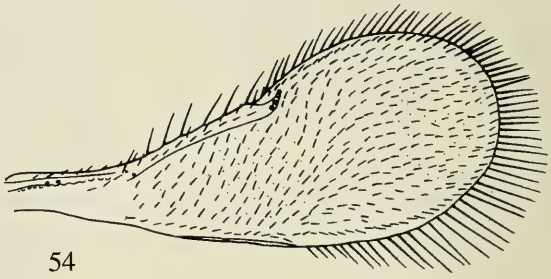

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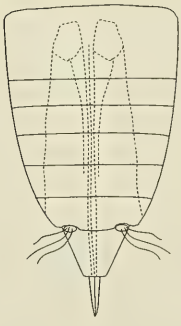

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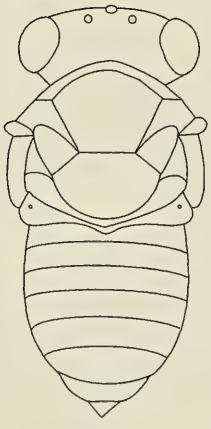

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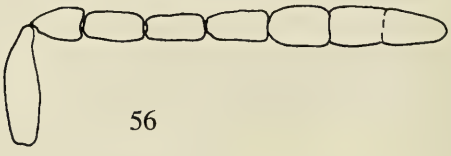

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Figs. 49–56. 49, Habitus, *E. pergandiella.* 50, Female antenna, *E. pergandiella.* 51, Forewing, *E. pergandiella.* 52, Habitus, *E. portoricensis.* 53, Habitus, *E. protransvena.* 54, Forewing, *E. protransvena.* 55, Metasoma, *E. protransvena.* 56, Female antenna, *E. protransvena.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect body proportions.

brown, posterior mesoscutum, scutellum and posterior axillae yellow (Fig. 52); midtarsus 5-segmented; forewing without asetose spot near stigmal vein; scutellar sensilla round and separated slightly less than 2× their own diameter (as in Fig. 69); ovipositor as long as metasoma and slightly exserted. This species is very similar to *townsendi.* It can be separated from that species by the color of the mesosoma (*townsendi* has only the scutellum yellow) and the separation of the scutellar sensilla (sensilla separated about 3.5× their own diameter in *townsendi*).

Host: *Aleyrodes* sp., *Aleurodicus antillensis* Dozier.

Distribution: Mexico and Puerto Rico.

Notes: In his original description, Howard (1907) noted that he had a specimen of this species from Mexico (the types were from Puerto Rico). I have been unable to find this specimen in the USNM collection and this diagnosis is based upon the Puerto Rican specimens. Some specimens collected by Dozier (USNM) have the posterior metasoma fading to yellow and the head lighter orange than the types.

Encarsia protransvena Viggiani
(Figs. 53–56)

Encarsia protransvena Viggiani 1985: 89.

Diagnosis: Body yellow in color (Fig. 53). Mid tarsi 5-segmented; forewing without an asetose area under the stigmal vein, membrane without infuscation below marginal vein and without lengthened setae along posterior wing margin (Fig. 54); scutellar sensilla close together, separated by less than 2× their diameter (as in Fig. 69); antenna with 3-segmented club (Fig. 56); ovipositor about as long as metasoma and appearing exserted (Fig. 55). This species is very similar to *strenua.* However, the ovipositor in *protransvena* is much longer (about equal to the length of the metasoma and appearing to be exserted) than in *strenua* (about ½ length of metasoma and not appearing exserted).

Hosts: *Aleurolobus subrotundus* Silvestri, *Dialeurodes citri* (Ashmead) (citrus whitefly), *D. citrifolii* (Morgan) (cloudy-winged whitefly), *D. kirkaldyi* (Kotinsky) (Kirkaldy whitefly).

Distribution: U.S. (FL), Puerto Rico.

Notes: Several specialists believe that this species is the same as *Encarsia armata* (Silvestri), a species known only from Vietnam. However, to date no synonymy of the two names has been published.

Encarsia quaintancei Howard
(Figs. 57–60)

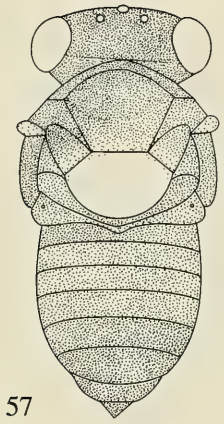
Encarsia quaintancei Howard 1907: 79.
Prospaltella perspicuipennis Girault 1910: 234.

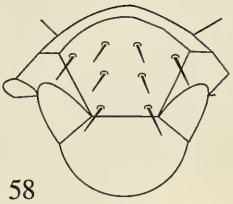
Diagnosis: Generally dark brown contrasting with bright-yellow scutellum (Fig. 57); midtarsus 4-segmented; forewing with asetose area around stigmal vein (Fig. 59); antenna with F1 and F2 subequal (Fig. 60); mesoscutum with 3 or 4 pairs of setae (Fig. 58). This species is most similar to *cubensis* but can be separated by the color of the metasoma (large anterior yellow spot in *cubensis*) and the antenna (F1 only about ½ as long as F2 in *cubensis*).

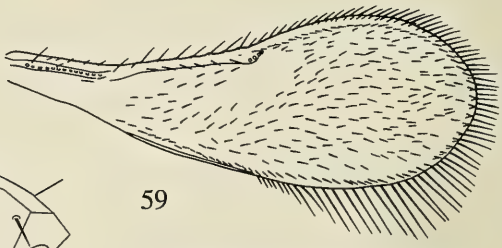
Male with F1 and F2 enlarged, F2 with rounded sensory structures. Males of this species are very similar to males of *nigricephala,* which also has the basal funicle segments enlarged. *E. nigricephala* males can be separated by the presence of only 2 pairs of mesoscutal setae (3–4 pairs in *quaintancei*) and F3 shorter than F2 (longer than F2 in *quaintancei*).

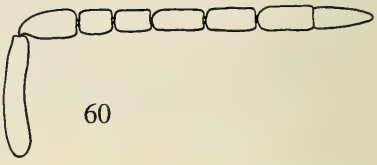
Hosts: *Aleurothrixus floccosus* (Maskell) (woolly whitefly), *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly), *Trialeurodes abutlioneus* (Haldeman) (banded-winged whitefly), *T. packardi* (Morill) (strawberry whitefly), *Trialeurodes* sp. Records of this species from *Aleyrodes* sp. are probably erroneous.

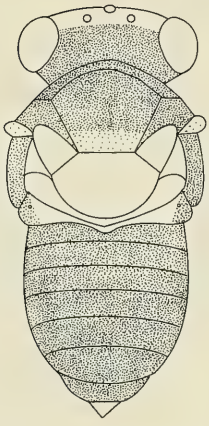
Distribution: U.S. (DC, FL, IL, LA, MD,

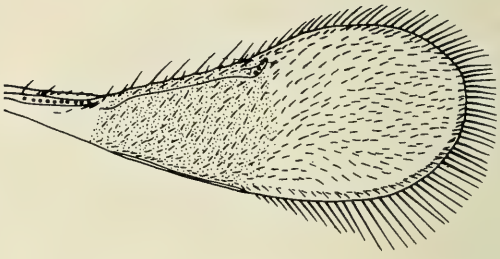


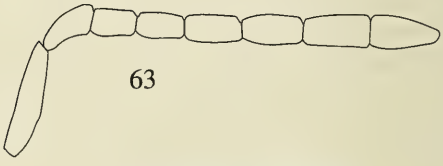


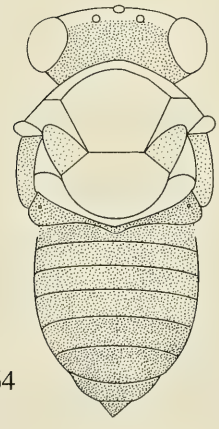


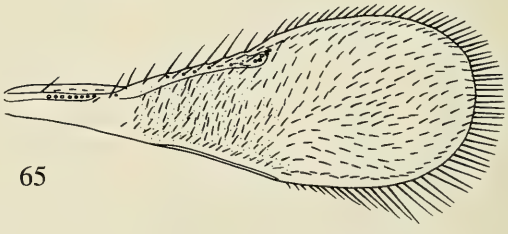


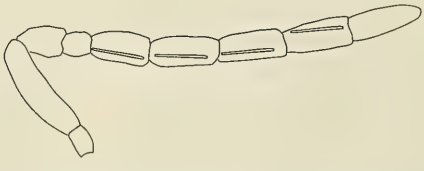












Figs. 57–66. 57, Habitus, *E. quaintancei.* 58, Dorsal mesosoma, *E. quaintancei.* 59, Forewing, *E. quaintancei.* 60, Female antenna, *E. quaintancei.* 61, Habitus, *E. quercicola.* 62, Forewing, *E. quercicola.* 63, Female antenna, *E. quercicola.* 64, Habitus, *E. smithi.* 65, Forewing, *E. smithi.* 66, Female antenna, *E. smithi.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect body proportions.

MS), Mexico, El Salvador, Venezuela, and the Caribbean.

Encarsia quercicola (Howard)
(Figs. 61–63)

Prospaltella quercicola Howard 1908: 282.

Diagnosis: Body mostly dark brown except for yellow scutellum and surrounding area (Fig. 61); midtarsus 5-segmented; forewing without asetose area adjacent to stigmal vein and with a lightly infuscate area under marginal vein (Fig. 62); antennal club 2-segmented (Fig. 63); scutellar sensilla only separated by about 2× their diameter or less (as in Fig. 69). This species is closest to *citrella* and can be separated by the first antennal funicle (subequal to F2 in *quercicola* but only ½ length of F2 in *citrella*) and body color (mostly yellow in *citrella*).

Hosts: *Aleuroplatus coronata* (Quaintance), *A. gelatinosus* (Cockerell).

Distribution: U.S. (CA).

Encarsia smithi (Silvestri)
(Figs. 64–66)

Prospaltella smithi Silvestri 1926: 179.

Diagnosis: Head and most of mesosoma light brown, most of mesoscutum and scutellum orangish, propodeum and metasoma dark brown to black (Fig. 64); midtarsus 5-segmented; forewing without asetose area under stigmal vein, with light infuscation under marginal vein (Fig. 65); scutellar sensilla separated by more than 2× their own diameter (as in Fig. 25); antenna with F1 about ½ length of F2 (Fig. 66); ovipositor not exserted beyond tip of abdomen. This species will key to near *divergens* which is very similar in coloration. However, *divergens* has no noticeable infuscation on the forewing and F2 of the antenna is longer (about 2.5× as long as F1).

Hosts: *Aleurocanthus citriperdus* Quaintance and Baker, *A. spiniferus* (Quaintance) (orange spiny whitefly), *A. woglumi* Ashby (citrus blackfly).

Distribution: Mexico, Cuba, Asia.

Encarsia strenua (Silvestri)
(Figs. 67–70)

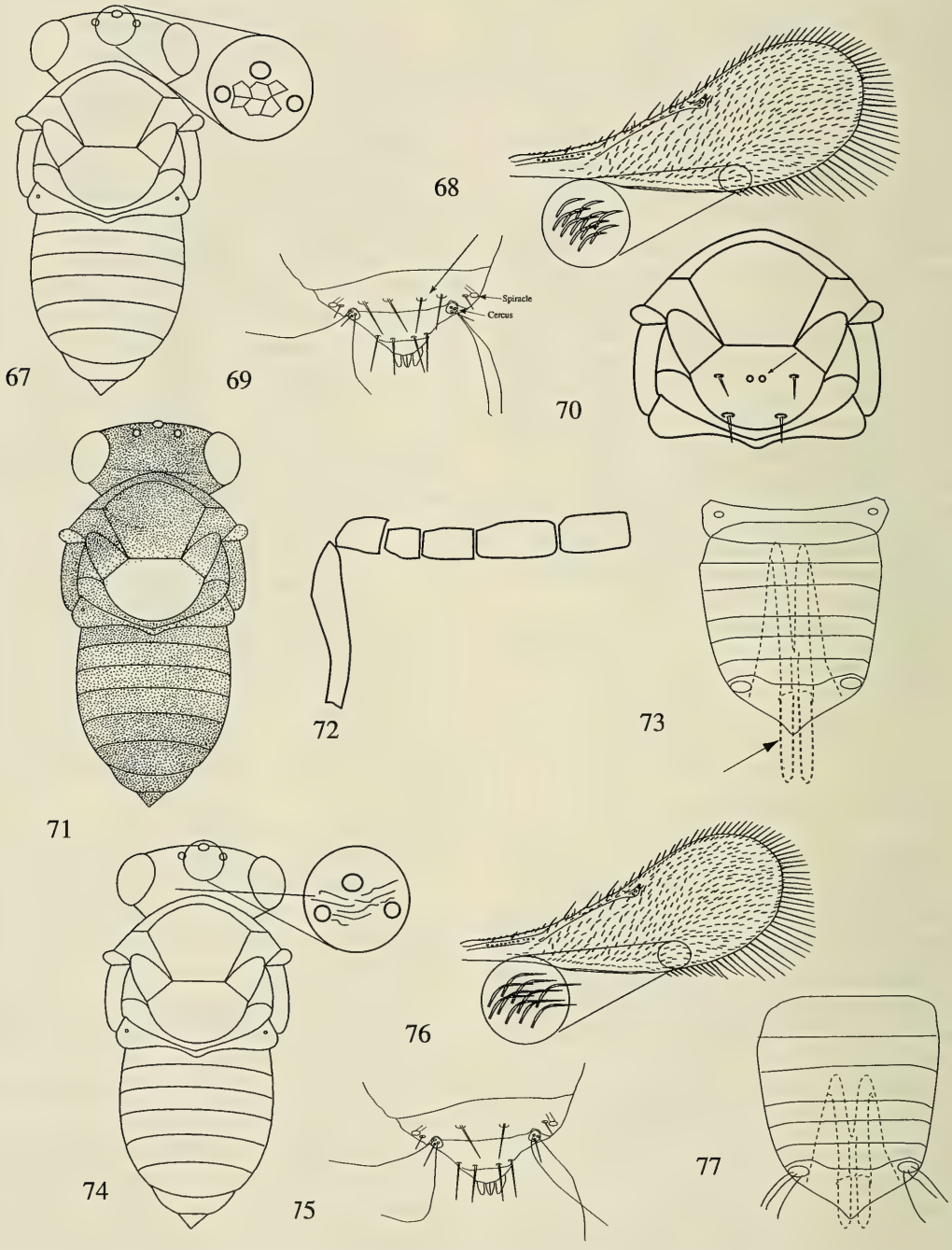
Prospaltella strenua Silvestri 1927: 34.

Diagnosis: Body yellow (Fig. 67); midtarsus 5-segmented; forewing without an asetose area under the stigmal vein, membrane without infuscation below marginal vein and without lengthened setae along posterior wing margin (Fig. 68); scutellar sensilla separated by less than 2× their diameter, often nearly touching (Fig. 70); vertex with reticulate sculpture (Fig. 67); metasoma with 2 pairs of setae medially between the cerci (Fig. 69); ovipositor only about half as long as metasoma and not appearing exserted. This species is very similar to both *transvena* and *protransvena*. *Encarsia protransvena* can be separated by the longer ovipositor (about equal in length to the metasoma and appearing exserted beyond the tip). *E. transvena* has striate sculpturing on the vertex (difficult to assess in many specimens), only one pair of setae between the cerci (Fig. 75), and a patch of elongated setae on the hind margin of the wing.

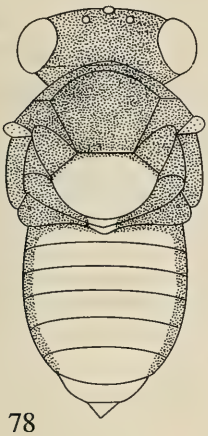
Hosts: *B. argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly), *Bemisia giffardi* (Kotinsky) (Giffard whitefly), *Dialeurodes citri* (Ashmead) (citrus whitefly), *D. citrifolii* (Morgan) (cloudywinged whitefly), *D. kirkaldyi* (Kotinsky) (Kirkaldy whitefly), *Trialeurodes packardi* (Morrill) (strawberry whitefly).

Distribution: U.S. (CA, FL). Puerto Rico, Honduras, Asia.

Notes: The limits of this group of species (*strenua, transvena,* or *protransvena*) are the subject of continuing debate and separating them can be difficult and requires properly cleared and mounted specimens. Some characters, such as the length of setae on the forewing require experience or exemplars of the other species for comparison. Assessment of the sculpture of the vertex requires specimens mounted in the proper position. The most reliable character



Figs. 67–77. 67, Habitus, *Encarsia strenua.* 68, Forewing, *E. strenua.* 69, Dorsal posterior metasoma, *E. strenua.* 70, Dorsal mesosoma, *E. strenua.* 71, Habitus, *E. townsendi.* 72, Female antenna, *E. townsendi.* 73, metasoma, *E. townsendi.* 74, Habitus, *E. transvena.* 75, Dorsal posterior metasoma, *E. transvena.* 76, Forewing, *E. transvena.* 77, Metasoma, *E. transvena.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect body proportions.



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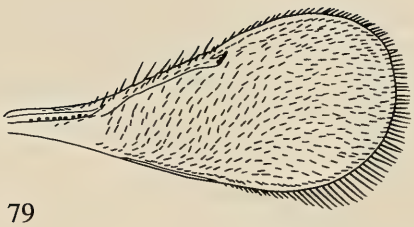

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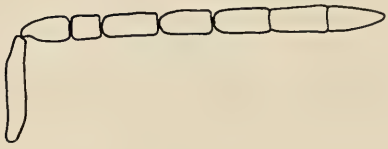

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Figs. 78–80. 78, Habitus, *E. variegata.* 79, Forewing, *E. variegata.* 80, Female antenna, *E. variegata.* Note: Habitus drawings indicate general coloration patterns and may not accurately reflect body proportions.

appears to be the number of setae between the cerci.

Encarsia townsendi Howard
(Figs. 71–73)

Encarsia townsendi Howard 1907: 78.

Diagnosis: Body brown with yellowish scutellum (Fig. 71). Mid tarsi 5-segmented; forewing without asetose area under stigmal vein; antennae with F2 longer than F1 (Fig. 72); scutellar sensilla separated by about 3.5× their own diameter and scutellum with 2 pairs of equal-sized setae; ovipositor long, as long as metasoma and exserted (Fig. 73), terminal ovipositor sheaths about ½ length of midtibia. This species is very similar to *E. portoricensis* which shares the elongated terminal ovipositor sheaths of this species. It can be differentiated from that species by the color of the mesosoma (scutellum, posterior mesoscutum and part of axillae yellow in *portoricensis*) and the separation of the scutellar sensilla (sensilla separated slightly less than 2× their own diameter in *portoricensis*).

Hosts: *Aleyrodes* sp.

Distribution: Mexico.

Encarsia transvena (Timberlake)
(Figs. 74–77)

Prospaltella transvena Timberlake 1926: 312.

Prospaltella sublutea Silvestri 1931: 20.

Prospaltella flava Shafee 1973: 254 (preoc. by *flavus* Compere, 1936).

Encarsia shafeei Hayat 1989: 72 (replacement name for flava Shafee).

Prospaltella bemisiae Ishii 1938: 30.

Diagnosis: Body yellowish (Fig. 74); midtarsus 5-segmented; vertex with striate sculpture between ocelli (Fig. 74); forewing without asetose area under stigmal vein and with area of elongated setae near posterior edge of membrane (Fig. 76); antennae with F2 longer than F1; scutellar sensilla separated by less than 2× their own diameter, and scutellum with 2 pairs of equal sized setae; metasoma with a single pair of setae medially between the cerci (Fig. 75); ovipositor only about half as long as metasoma and not appearing exserted (Fig. 77). This species is very similar to *strenua* and it can be very difficult to tell the two apart. The wing character (group of longer setae in *transvena* and shorter setae in *strenua*) can be difficult to assess without specimens of both species for comparison. The presence of only a single pair of setae between the cerci on the dorsal metasoma separates *strenua* (two pairs of setae between cerci) and the pattern of sculpture on the vertex seems reliable (striate in *transvena* and reticulate in *strenua*) but is also often difficult

Table 1. List of whitefly species with North American *Encarsia* species that have been reared from them.

Whitefly species	*Encarsia* species
Acaudaleyrodes citri (Priesner and Hosny)	*inaron, lutea*
Aleurocanthus citriperdus Quaintance and Baker	*divergens, merceti, opulenta, smithi*
A. longispinus Quaintance and Baker	*divergens*
A. spiniferus (Quaintance)	*divergens, merceti, opulenta, smithi*
A. woglumi Ashby	*clypealis, divergens, merceti, opulenta, smithi*
Aleurocybotus occiduus Russell	*luteola*
Aleurocybotus indicus David and Subramaniam	*transvena*
Aleurodes sp.	*townsendi*
Aleurodicus antillensis Dozier	*portoricensis*
A. dispersus Russell	*lahorensis, pergandiella, transvena*
A. sp.	*variegata*
Aleuroglandulus malangae Russell	*formosa, meritoria, pergandiella*
Aleurolobus subrotundus Silvestri	*protransvena*
Aleuroplatus coronata (Quaintance)	*citrella, pergandiella, quercicola*
A. gelatinosus (Cockerell)	*quercicola*
A. elemerae Mound and Halsey	*pergandiella*
A. liquidambaris Russell	*citrella*
Aleurothrixus floccosus (Maskell)	*americana, basicincta, cubensis, pergandiella, quaintancei, variegata*
A. porteri Quaintance and Baker	*meritoria*
Aleurotrachelus trachoides (Back)	*formosa, pergandiella*
Aleyrodes lonicerae Walker	*formosa, inaron*
A. proletella (L.)	*formosa, inaron*
Aleyrodes pruniosus Bemis	*peltata*
A. singularis Danzig	*inaron*
A. spiraeoides Quaintance	*formosa, meritoria*
Aleyrodes sp.	*coquilletti, luteola, pergandiella, portoricensis*
Asterobemisia carpini (Koch)	*inaron*
A. paveli (Zahradnik)	*inaron*
Bemisia argentifolii Bellows and Perring	*citrella, formosa, inaron, lutea, luteola, nigricephala, pergandiella, quaintancei, strenua, transvena*
Bemisia giffardi (Kotinsky)	*strenua*
Bemisia sp.	
inaron	
Bulgarialeurodes cotesii (Maskell)	*inaron*
Crenidorsum sp.	*formosa*
Dialeurodes chittendeni Laing	*formosa*
D. citri (Ashmead)	*formosa, lahorensis, pergandiella, protransvena, strenua*
D. citrifolii (Morgan)	*lahorensis, protransvena, strenua*
D. kirkaldyi (Kotinsky)	*lahorensis, pergandiella, protransvena, strenua*

Table 1. Continued.

Whitefly species	*Encarsia* species
D. sp.	*luteola, meritoria*
Parabemisia myricae (Kuwana)	*transvena*
Paraleyrodes perseae (Quaintance)	*variegata*
P. naranjae (Quaintance)	*variegata*
Siphoninus immaculatus (Heeger)	*inaron*
S. phillyreae (Haliday)	*inaron, meritoria*
Tetraleurodes mori (Quaintance)	*formosa*
T. ursorum (Cockerell)	*basicincta*
Trialeurodes abutiloneus (Haldeman)	*formosa, luteola, nigricephala pergandiella, quaintancei*
T. ferrnaldi (Morill)	*luteola*
T. floridensis (Quaintance)	*nigricephala, pergandiella*
T. packardi (Morill)	*luteola, quaintancei, strenua*
T. ricini (Misra)	*lahorensis* (not confirmed)
T. vaporariorum (Westwood)	*formosa, inaron, lutea, luteola, nigricephala, pergandiella, transvena*
T. variabilis (Quaintance)	*formosa, luteola, pergandiella*
T. sp.	*quaintancei*

to assess because in many mounted specimens the head is at the wrong angle or is incompletely cleared.

Hosts: *Aleurocybotus indicus* David and Subramaniam, *Aleurodicus dispersus* Russell, *Bemisia argentifolii* Bellows and Perring (formerly *B. tabaci* (Bellows et al. 1994)) (silverleaf whitefly), *Parabemisia myricae* (Kuwana), *Trialeurodes vaporariorum* (Westwood) (greenhouse whitefly).

Distribution: U.S. (CA, FL). Mexico and occurs over almost all of the Old World.

Encarsia variegata Howard (Figs. 78–80)

Encarsia variegata Howard 1908: 64.

Diagnosis: Head, mesoscutum and anterior scutellum dark brown; scutellum and metasoma (except laterally) yellow (Fig. 78); midtarsus 4-segmented; forewing uniformly setose around stigmal vein (Fig. 79); distance between scutellar sensilla greater than 2× their diameter (as in Fig. 25), F1 only about ½ as long as F2 (Fig. 80). This species is quite close to *luteola* and *formosa* and can be separated by color (*luteola* and *formosa* have the entire mesosoma uniformly brown to dark brown).

Hosts: *Aleurodicus* sp., *Aleurothrixus floccosus* (Maskell) (woolly whitefly), *Paraleyrodes perseae* (Quaintance), *P. naranjae* (Quaintance) (plumeria whitefly).

Distribution: U.S. (CA, FL). Also occurs in the Caribbean and Mexico.

Acknowledgments

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IMMATURE STAGES OF *SCAPHISOMA CASTANEUM* MOTSCHULSKY (COLEOPTERA: STAPHYLINIDAE: SCAPHIDIINAE), WITH OBSERVATIONS ON NATURAL HISTORY, FUNGAL HOSTS AND DEVELOPMENT

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Abstract.—Eggs, larvae, pupae and known aspects of the life history and habits of *Scaphisoma castaneum* Motschulsky are described based upon field collected and laboratory reared material. Immatures were collected and reared from the polypore fungus *Auriporia aurea* (Peck) Ryvarden found within a downed log of *Pinus ponderosa* Douglas. Approximate duration of the developmental stages at room temperature (22–24°C) in days were: egg 4–6; larvae, instar I, 1–2; instar II, 2–4; instar III, 4–6; prepupa, 1–2; pupa, 9–12. Complete developmental time of *S. castaneum* ranged from 21–25 days (mean 22). Second and third larval instars were observed to construct longitudinal, meshwork-like canopies from digested food excreted from the anus over occupied parts of the host fungus. Descriptive illustrations of the third larval instar and pupa are provided. Morphological and behavioral comparisons to *S. impunctatum* Reitter, the only other species of New World *Scaphisoma* with described immatures and habits, are made.

Key Words: Coleoptera, Staphylinidae, Scaphidiinae, *Scaphisoma castaneum, Auriporia aurea,* fungus feeding, immature stages, canopy-building behavior

Both larvae and adults of the genus *Scaphisoma* are known to occur in association with higher, fleshy fungi, wood debris and leaf litter (Hatch 1957, Lawrence and Newton 1980, Ashe 1984, Newton 1984, 1990, Leschen 1988, 1994, Leschen et al. 1990). Newton (1984) reported that fungal hyphae are probably the primary food source for most species of *Scaphisoma.* These hyphae are often, but not necessarily, from fruiting bodies of the host fungi, a feature which may explain the numerous specimens that are collected from wood debris and leaf litter.

North American species of *Scaphisoma* are known to feed on a wide variety of fungi, including coral fungi (Clavariaceae) (Newton 1984), gilled mushrooms (Agaricales) (Newton 1984, Leschen et al. 1990, pers. observ.), ground fan fungi (Thelophoraceae) (Leschen et al. 1990), jelly fungi (Heterobasidiomycetes) (Newton 1984, Leschen 1988, Leschen et al. 1990), polypore fungi (Polyporales) (Perris 1876, Weiss and West 1920, 1921, 1922, Newton 1984, Leschen 1988, pers. observ.), slime molds (Myxomycetes) (Newton 1984), white slime mold (Newton 1984), and mold (Moniliaceae) (Palm 1959).

Even with such numerous, diverse fungal hosts reported for species of *Scaphisoma,* little is known concerning natural histories, development and immature stages. Ashe (1984) comprehensively described the mature larva, pupa and natural history of *S. terminata* Melsheimer. However, in Les-

chen's (1988) description of the immatures and natural history of *S. impunctatum* Reitter, the specimens of *S. terminata* used in Ashe's study were revealed to be *Caryoscapha americanum* Löbl, a species described subsequent to Ashe's work. Additionally, no life histories of any species of *Scaphisoma* have been worked out in any detail.

The literature concerning immatures of *Scaphisoma* has been confused by misidentifications of larvae of *Sepedophilus* species as various species of *Scaphisoma* by numerous authors. Ashe (1984) and Newton (1984) reviewed the known misidentifications of larvae of *Scaphisoma* and possible implications to subsequent works dealing with immatures of the Scaphidiinae.

The objectives of this study are to describe the natural history, development, and immature stages of *S. castaneum* Motschulsky with patterns of evolutionary or taxonomic significance being noted. Adults of *S. castaneum* have been reported as common throughout Washington, Oregon, Idaho and British Columbia (Hatch 1957), however nothing is known concerning the immatures or habits of this species.

Material and Methods

To describe the life history, development and immature stages of *S. castaneum,* 52 eggs, 160 larvae, and 141 adults were collected from a mass of *Auriporia aurea* (Peck) Ryvarden (Polyporaceae). This fungus was found within a downed log of *Pinus ponderosa* Douglas at the Lyle Grove Biological Area, Whitman County, Washington.

Eggs, larvae and adults found on the fungus were brought alive into the laboratory and transferred to glass jars containing moist, sterile, potting soil. The jars were maintained at room temperature (22–24°C) and provided with pieces of the host fungus on wood bits as required (fragments of wood with the host fungus were kept refrigerated until needed). Behavioral and developmental observations were readily made under these conditions.

When full grown, larvae were allowed to pupate in the same containers. Samples of eggs, larval instars I, II, and III, prepupae, and pupae were killed and fixed in Kahle's solution and preserved in 80% ethyl alcohol. Specimens were prepared for structural examination by first clearing in cold 10% KOH for up to two days or until clear and then examining in glycerin. Specimens were examined with a stereo-dissecting microscope.

For the descriptions of the immature stages, 52 eggs, 28 larvae (3 instar I, 3 instar II and 22 instar III), 2 prepupae, and 27 pupae were studied. From the remaining immatures, 37 adult specimens of *S. castaneum* were successfully reared and preserved.

Results

Development. Three larval size groups are present in the preserved material, and these groups are interpreted as 3 larval instars. Male and female adults isolated in the laboratory readily mated, with the females depositing eggs in cracks and crevices on the host fungus within 36 hours after collection. Eclosion occurred approximately 12 hours after each egg was deposited, and within 36 hours all eggs had hatched.

Complete developmental time (eclosion to adult emergence) of *S. castaneum* averaged 22 days (range 21–25 days) at room temperature (Fig. 1). After feeding, the vast majority of full grown larvae burrowed from the fungus into the wood substrate forming small oval cavities lined with silk-like material secreted from the anus. Four of the larvae left the host fungus and buried themselves about 3 cm deep in the soil substrate forming similar chambers. The larvae remained non-feeding and inactive as prepupae in these cavities for 1–2 days before pupation. Pupation lasted between 9–12 days.

Host relationship. Gilbertson and Ryvarden (1986) and Breitenbach and Kränzlin

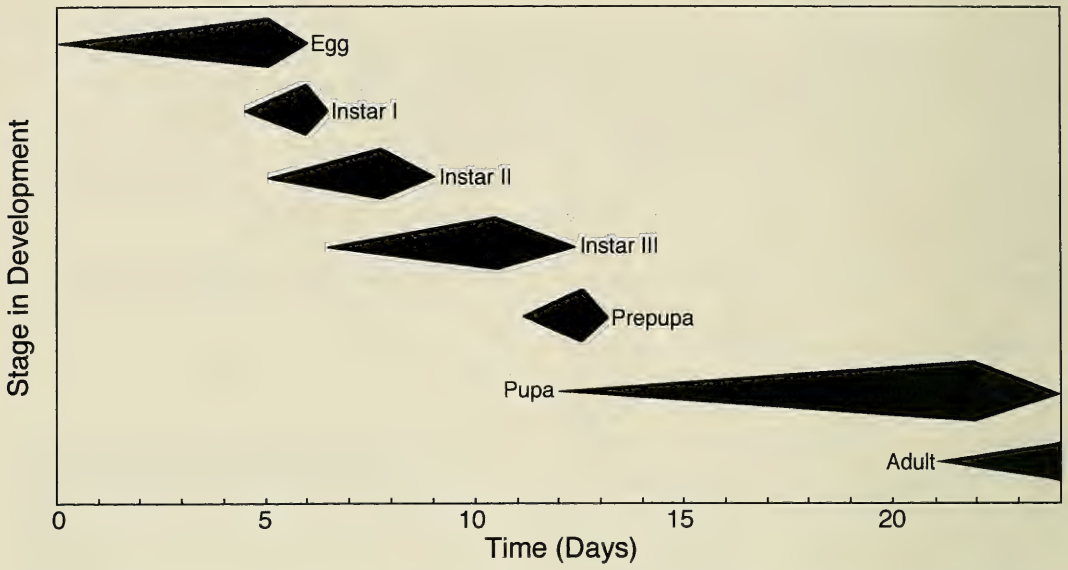


Fig. 1. Stages in the development of *Scaphisoma castaneum* Motschulsky with their duration and timing at room temperature (22–24°C). For each stage, the greatest width denotes all individuals have reached that stage. The apicies indicate first and last individuals found in that stage.

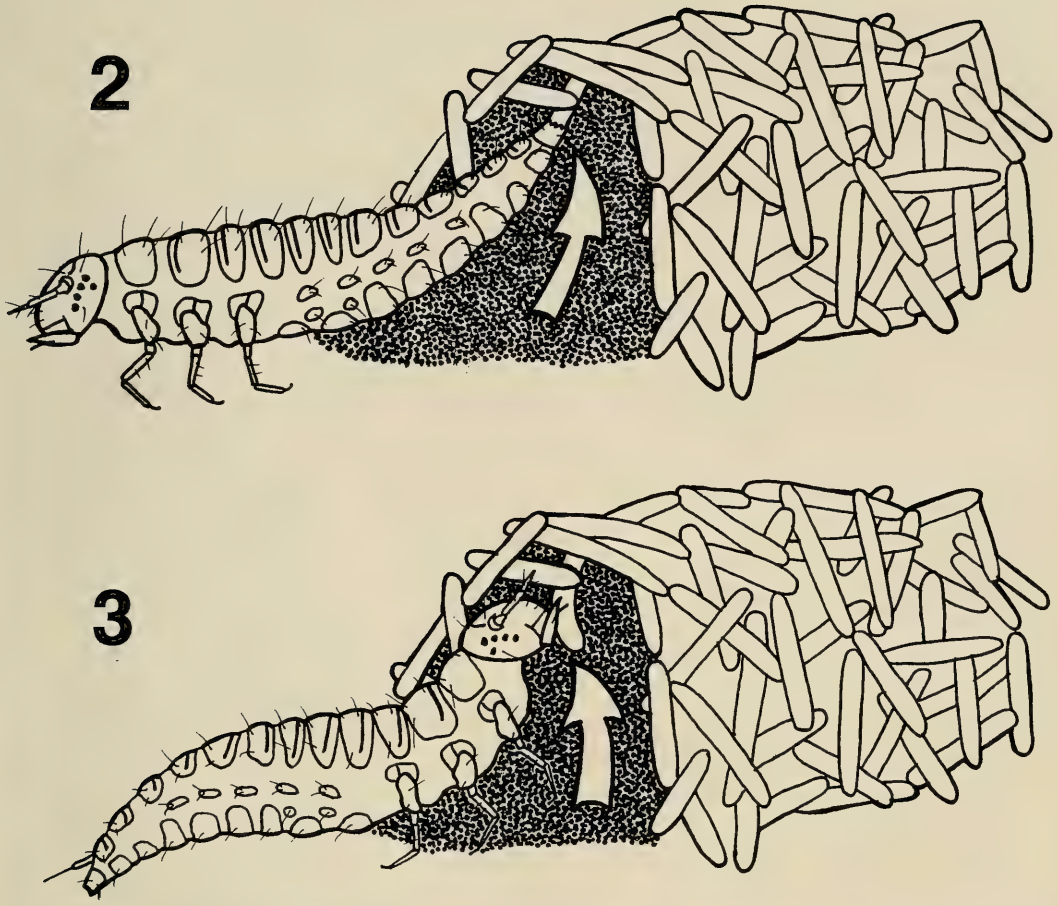
(1986) summarized our knowledge of *A. aurea*. This species is a resupinate to pileate, annual fungus causing brown cubical rot within dead conifers and hardwoods. The pore surface is yellow when fresh, turning yellowish-buff to pale brown upon drying. The pores are circular to angular with 2–4 per millimeter. The spores are cylindrical-ellipsoid and smooth, about 5.0–8.5 × 3.0–4.0 μ.

The genus *Auriporia* is exclusively a north temperate group with *A. aurea* the only species in North America. Known from the northeastern U.S., southwest and Pacific Northwest, *A. aurea* appears to be widely distributed throughout most of North America. However, this species is rarely collected, probably due to its cryptic nature of occurring within downed logs. Two other species of *Auriporia* occur in Europe and Asia respectively.

Specimens of *S. castaneum* were encountered only on fresh, yellow areas of *A. aurea*. Both adults and larvae were collected together from the surface of the fungus. In many instances, the larvae and adults crawled down the narrow pores of the host fungus making hand collection of these specimens difficult. No trophic exchanges or other beneficial behaviors were directly observed between adults and larvae. Additional known adult hosts of *S. castaneum* are: *Pleurotus ostreatus* (Jacq. ex Fries) Kummer (pers. observ.), *Fomitopsis pinicola* (Swartz ex Fries) Karsten, *Polyporus alboluteus* Ellis and Everhart, and *Ganoderma* sp. (pers. comm., A. F. Newton, Jr.).

Feeding behavior. Larvae began grazing on the surface of *A. aurea* immediately after eclosion and fed both day and night during development.

Second and third larval instars were observed to construct longitudinal, meshwork-like canopies from digested food excreted from the anus over occupied parts of the host fungus (Fig. 2). Larvae constructed the retreats by first excreting an elongated fecal pellet near the entrances of burrowed cavities, then reorienting themselves and positioning the fecal pellet into place using the mandibles (Fig. 3). The retreats were quite fragile and ephemeral, often decaying in about 48 hours. The fecal pellets were held together with a viscous fluid and did not



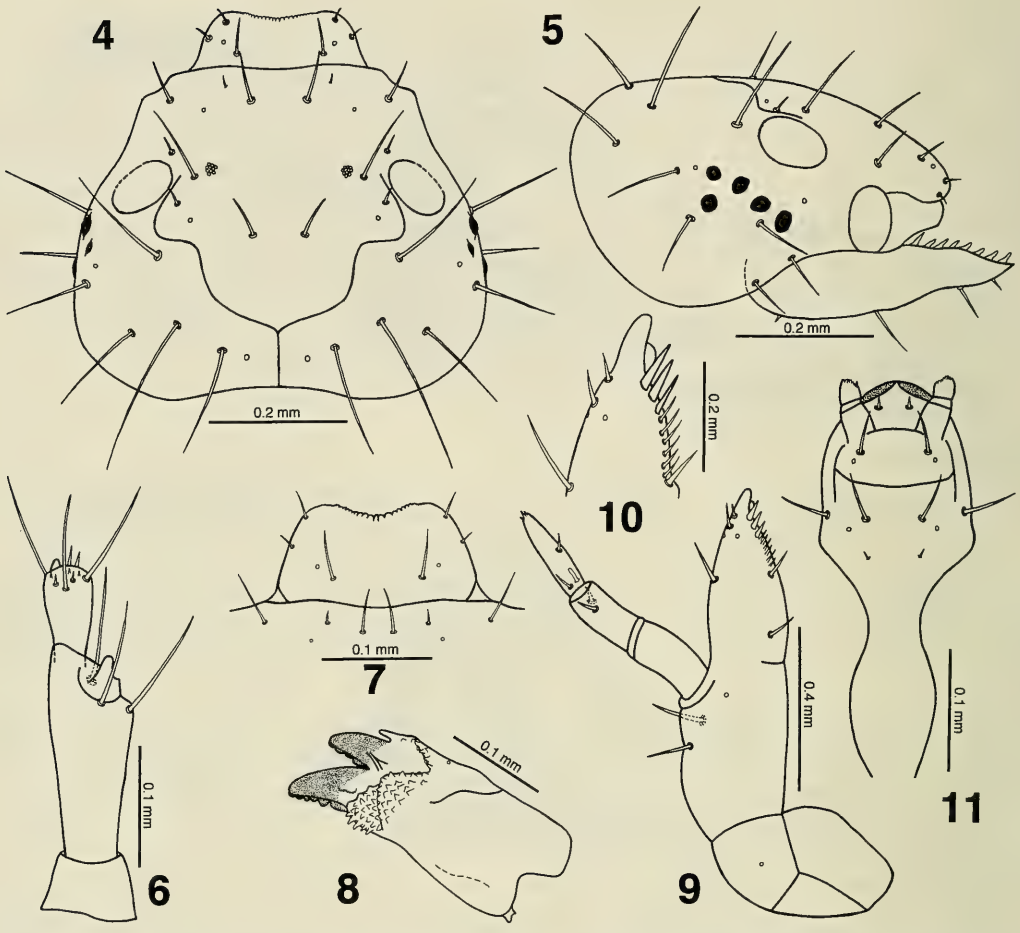
Figs. 2, 3. Retreat construction behavior of second and third larval instars of *Scaphisoma castaneum* Motschulsky. 2, Deposition of a fecal pellet into the canopy of the retreat. 3, Final manipulation of the fecal pellet into place using the mandibles.

appear to be arranged in any definite pattern. Each retreat was approximately 2 cm long and was occupied by a single larva. While in the retreats, larvae fed on the surface of the fungus and repaired any damaged areas to the retreats. The function of the excavated retreats remains unclear, however, they probably serve as an adaptation to hide the larvae from potential predators/parasites and/or to provide suitable microhabitats perhaps to prevent desiccation. To this end, one behavioral observation is of note: when a shadow passed over a retreat, the larva immediately crawled back into its retreat. This observation suggests a probable anti-predatory function for these retreats.

Immature Stages of *Scaphisoma castaneum* Motschulsky

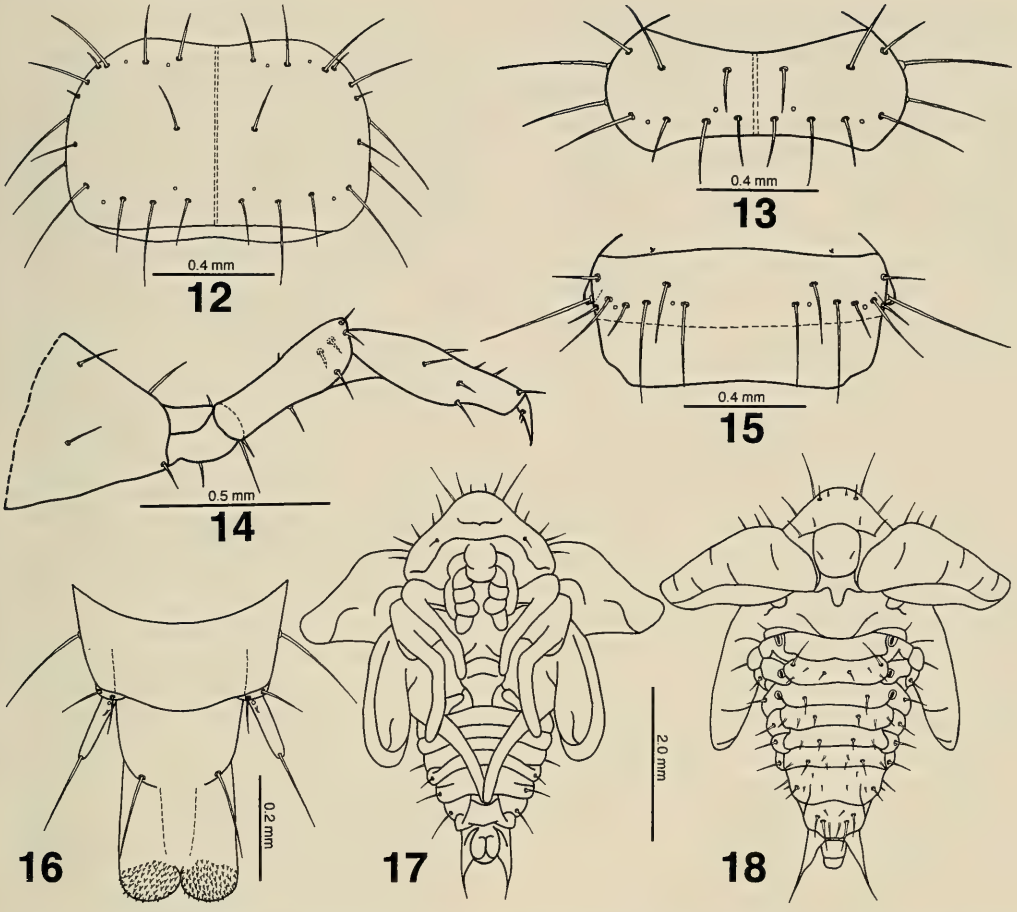
Description of egg. Length 0.3–0.6 mm. Color white, smooth, spherical, surrounded by mucous-like substance.

Description of larval instar III. Length 2.9–4.3 mm. Body elongate, gently curved, parallel-sided, flattened dorsoventrally. Color whitish with sclerotized areas light brown; head dark yellow to brown. Vestiture length variable, setae simple. Head oval, length about 0.9 times width; ecdysial



Figs. 4–11. *Scaphisoma castaneum* Motschulsky, larval instar III. 4, Head (dorsal view). 5, Head (lateral view). 6, Antenna (ventral view). 7, Labrum (dorsal view). 8, Mandible (ventral view). 9, Maxilla (dorsal view). 10, Mala of maxilla (dorsal view). 11, Labium (ventral view).

lines distinct, lateral arms lyre-shaped, complete from back of head to bases of antennae with near right angles midway between antenna fossae and fork; epicranial glands distinct, near end of ecdysial lines (Fig. 4); five pigmented stemmata on each side, arranged in one distinct row with one stemma below row (Fig. 5). Antenna with segment I asetose, short, length about 0.6 times width; segment II about 4.0 times longer than segment I, constricted portion 0.25 times length, segment II trisetose, bearing small, mesal, sensory appendage; segment III about 0.4 times length of segment II, three prominent, long setae surround numerous small, fine setae (Fig. 6). Labrum with anterior margin serrate, 8–9 tooth-like projections on each side of midline; surface with three pairs of setae (Fig. 7). Adoral surface of labrum (epipharynx) with numerous, very fine, inwardly and anteriorly directed hairlike processes on each side of midline; small patch of sensory pores present near anterior surface. Mandibles with right and left similar in size and shape; broad, with extensive pseudomola of numerous small teeth, asetose; divided into two acute lobes with ventral lobe larger than dorsal lobe; margins of lobes prominently serrate (Fig. 8). Maxilla (Fig. 9) with



Figs. 12–18. *Scaphisoma castaneum* Motschulsky. 12–16, Larval instar III. 12, Pronotum (dorsal view). 13, Mesonotum (dorsal view). 14, Prothoracic leg (anterior view). 15, Abdominal tergum I. 16, Abdominal terga IX and X. 17, 18, Pupa: 17, Ventral aspect. 18, Dorsal aspect.

cardo oval, divided into three regions; stipes broadest at middle, tapering slightly at base; mala acute with a large, unarticulated spine at apex and two smaller, articulated spines more proximally on mesal surface; adoral surface with 9–10 closely spaced, spine-like setae in a single row (Fig. 10); maxillary palpus three-segmented not including basal palpifer, segment I asetose, about 0.8 times the length of segment II, segment II bisetose, segment III conical and bisetose, about 1.4 times as long as segment II, base with very small digitform sensory appendage, apex with three very short setae at apex. Labium composed of submental, mental and premental sclerites; ligula broadly rounded with spines on each side of the midline; labial palpus 2-segmented, short, stub-like, segment I about 1.4 times longer than segment II, segment II with 3–4 very short setae at apex (Fig. 11). Thorax. Pronotum transverse, moderately sclerotized, anterior and posterior angles broadly rounded; ecdysial suture well developed medially (Fig. 12). Mesonotum oval, width about 3.7 times length, moderately sclerotized; ecdysial suture well developed (Fig. 13). Metanotum similar to mesonotum. Legs long, each of similar size and configuration; 4 setae present on coxae, 4 setae on trochanter, 7 setae on both femur and tibia, and 2 minute setae present on tarsus;

all setae of various sizes (Fig. 14). Abdomen. Tergum I quadrate, width about 2.2 times length, lightly sclerotized with small tergal gland on each side; ecdysial suture absent (Fig. 15). Terga II–VIII similar to tergum I. Tergum IX quadrate, width about 2.2 times length; one pair of setae present. Urogomphi two segmented; basal segment with 2 setae; segment II slender, 0.75 times length of tergum IX. Tergum X elongate, slightly tapered from base to apex; apex with two large, round lobes covered with many minute hooks (Fig. 16).

Variation in larval instars. Overall body lengths of each instar are as follows: instar I, 0.9–1.3 mm; instar II, 1.4–2.7 mm; instar III 2.9–4.3 mm. Structurally, the first instar differs from the second and third as follows: head not pigmented; antennae shorter and more robust; anterior margin of labrum deeply crenulate; general reduction in setation over entire body. The second instar differs from the third as follows: head yellow; anterior margin of labrum crenulate; legs shorter and more robust; setation of body similar.

Description of pupa. Length 1.9–2.8 mm. Color white throughout. Eyes inconspicuous. Major body spines as in Figs. 17, 18. General body form broadly oval with wing pads distinctive. Three pairs of functional spiracles near the lateral margin on each thoracic segment.

Material examined. USA. WASHINGTON. WHITMAN Co.: Lyle Grove Biological Area, 12.9 km SW of Pullman, 640 m elev., 12 May 1994 and 21 May 1994, R. S. Hanley & W. J. Turner, from *Auriporia aurea* in downed log of *Pinus ponderosa.* Fifty-two eggs, 160 larvae and 141 associated adults; 2 prepupae, 27 pupae and 37 reared adults.

Voucher specimens were deposited in the James Entomological Collection, Washington State University and the remainder in the personal collections of the author and W. J. Turner, Washington State University.

Discussion

The mature larvae of *S. castaneum* are very similar to those of *S. impunctatum* reported by Leschen (1988). Larvae of *S. castaneum* differ primarily from larvae of *S. impunctatum* in the following major ways: ecdysial lines with distinct right angle curve near antennal fossae; ocelli arranged in one distinct row with one stemma below; posterior head setation about 1.5 times longer overall; antennae with sensory appendage on segment II about half as large; apical tip of mala distinctly rounded; maxillary palpus segment III with basal digitform sensory appendage about half as large; labium with palpi extending beyond anterior margin, lateral margins of submentum distinctly compressed; urogomphi about 1.5 times longer.

The mucous-like substance surrounding the eggs of *S. castaneum* probably serves as an important means of water regulation within the eggs. A similar substance was reported surrounding the eggs of *S. impunctatum* (Leschen 1988).

Other scaphidiine beetles are also known to construct retreat canopies similar to those described for *S. castaneum.* Leschen (1994) reported that larvae of the genera *Scaphidium* and *Toxidium* construct retreat canopies near or on the mycelium of host fungi. These retreats were constructed by each larva positioning elongated fecal pellets into a roof made of frass using their mandibles, as seen in *Scaphidium,* or their anus, as in *Toxidium.* The larvae of *Caryoscapha americanum* used in Ashe's (1984) study were also reported to construct retreats by excavating incomplete longitudinal caverns within the host mushroom.

Leschen (1994) suggests that retreat building behavior in species of *Toxidium* and *Scaphidium* may be convergent with preliminary evidence suggesting that retreat building may be more widespread throughout the Scaphidiinae than previously known. I agree with Leschen's comment that interpreting retreat building as a ho-

mology requires additional natural history studies from other scaphidiine taxa.

The silk-lined pupal chambers produced by mature larvae of *S. castaneum* likely serve a protective function by forming a hard enclosing layer of wood or soil particles around each pupa. It is unclear if these chambers are an adaptation to avoid predation/parasitism or simply to allow pupation within loose substrates, such as sandy soil or fragmented wood. Similar cavities have been reported for most described members of the Aleocharinae and species of the paederine genus *Astenus* (Frank and Thomas 1984). No previous descriptions of the natural histories or habits of immatures of *Scaphisoma* include a silk-lined pupal chamber. However, very little is known about scaphidiine pupae and discussions of the habits of pupation are based on incomplete comparative data.

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APHIS CRASSICAUDA, N. SP. (HOMOPTERA: APHIDIDAE), WITH A KEY TO ALATE SPECIES OF *APHIS* ON *VIBURNUM* SPP. IN THE UNITED STATES

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Abstract.—All morphs (fundatrices, apterous viviparous females, alate viviparous female, apterous oviparous females, and apterous males) of ***Aphis crassicauda*, n. sp.**, are described. Collections were made in Wake and Orange counties, NC; Starved Rock State Park, IL; and Phillipsburg, PA. A key is given to the alate viviparous females of the following species of *Aphis* reported on *Viburnum* spp. in the United States: *A. crassicauda*; *A. spiraecola* Patch, *A. viburni* Scopoli, *A. viburnicola* Gillette, and *A. viburniphila* Patch.

Key Words: Aphididae, *Aphis,* Viburnum, United States, key

Aphis crassicauda Smith and Eckel, n. sp., was found on heavily infested plants of *Viburnum dentatum* that had been used in landscaping at a new office building in Umstead State Park (Wake Co.), NC. All morphs (fundatrices, alate viviparous females, apterous viviparous females, apterous oviparous females, apterous males, and eggs) were collected on these bushes during 1959 and 1960. *Aphis crasscauda* has not been collected colonizing on other genera of plants.

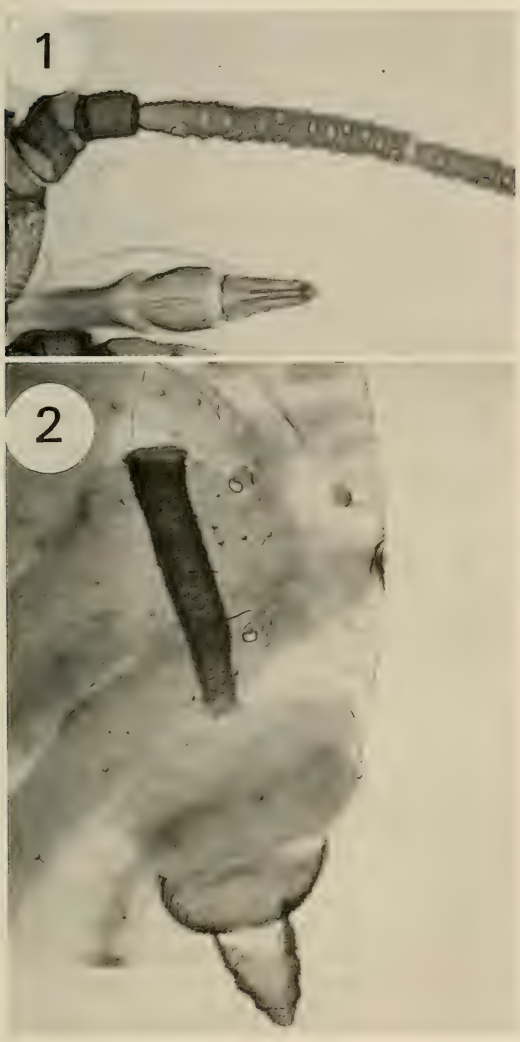
Other collections of *A. crassicauda* have been made on other plants of *Viburnum dentatum* in other areas of Umstead Park, Reedy Creek State Park, and Orange Co., NC, and in Starved Rock State Park, IL, and Phillipsburg, PA. However, plants at these areas were not as heavily infested as the transplanted plants. Could the transplanting of the plants have affected them in such a way that they were very favorable food for the aphids?

Aphis viburni Scopoli has been reported from Illinois, Kansas, and Nebraska (see Thomas 1879, Smith and Parron 1978:47), but we have not seen specimens from North America.

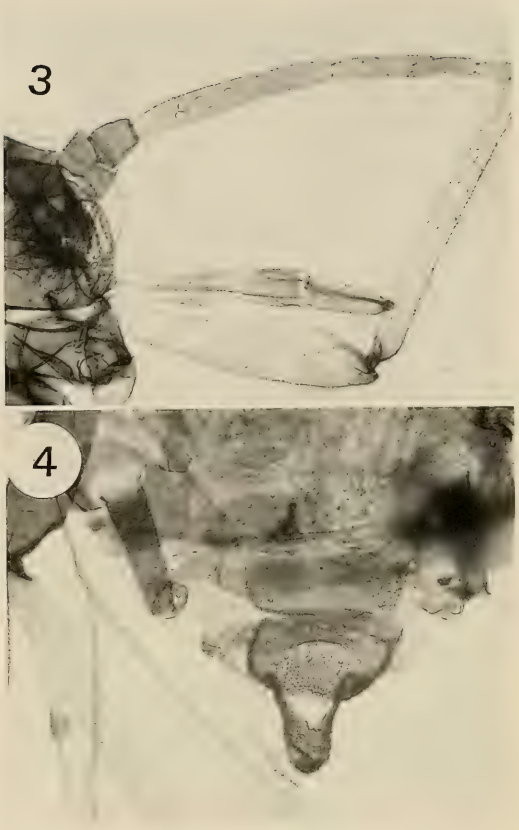
Aphis crassicauda Smith and Eckel, New Species

Fundatrices (Fig. 7).—Color of living specimens, tan to light brown. Cleared specimens: Dusky on head; antennal segments I, II, III–IV (distal tip), V and VI; rostral III and IV+V; thorax (lateral plates); legs dusky on coxae, trochanters, femorae (distal three-fourths), tibiae (distal one-tenth), tarsi; siphunculi; cauda; anal and genital plates.

Measurements (the first is that of a single specimen (60-26 #1), the measurements in parentheses represent the range of 8 specimens unless indicated otherwise). All measurements in millimeters. Length of body, 1.8 (1.8–2.0, 4 specimens); width of head, 0.45 (0.42–0.48); antennae with 5 segments (antennal segments III–IV apparently combined, V and VI have primary rhinaria) without secondary rhinaria. Antennal segment III–IV, 0.35 (0.21–0.37), V, 0.15 (0.12–0.19), VI, 0.10 (0.10–0.12) + 0.17



Figs. 1, 2. *Aphis viburnicola,* alate viviparous female, Grand Jct., Colo. (Paul and Carolynn Sanda), 28 April 1993, on *Viburnum* sp. 1, Portion of head, antenna and rostrum. 2, Tip of abdomen with siphunculus and cauda.

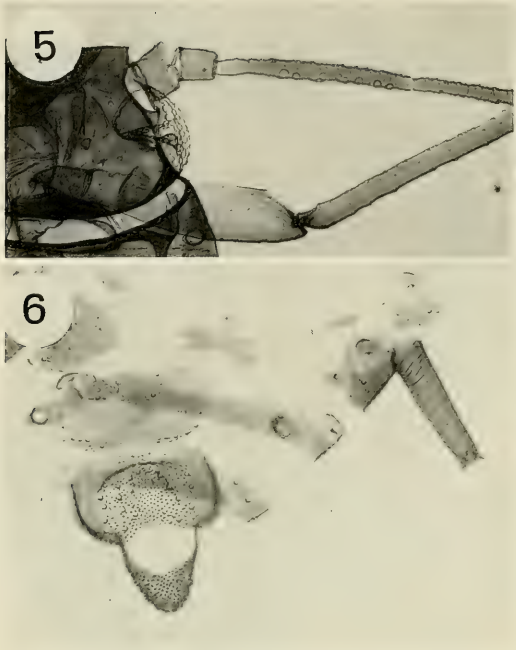


Figs. 3, 4. *Aphis viburni,* Skive, Denmark (O. Heie), 19 July 1958, on *Viburnum opalus,* alate viviparous female. 3, Portion of head and antenna. 4, Tip of abdomen with siphunculi and cauda.

(0.12–0.17); Rostral IV+V, length 0.13 (0.10–0.14), width 0.08 (0.06–0.08); hind tibia, 0.89 (0.75–0.97); metatarsomere II, 0.11 (0.10–0.11); siphunculus, 0.22 (0.19–0.22); cauda, length 0.08 (0.06–0.09), width 0.15 (0.10–0.15), and bearing 11 setae (11–18). Antennae without secondary rhinaria. Unguis less than 2× base.

Apterous viviparous females.—Color of living specimens, tan to light brownish. Color of cleared specimens, dusky on head, antennal segments I, II, V and VI, legs, coxae, trochanters, femora, tibiae (types), tarsi, Rostral IV+V, siphunculi and cauda.

Measurements (the first measurement is that of a single specimen, the measurements in parentheses represent the range of 6 specimens). Length of body, 1.39 (1.10–2.08); width of head, 0.40 (0.35–0.48); antennae may be 5 or 6 segmented, usually 6; antennal segment III, 0.20 (0.19–0.35), IV, 0.08 (0.08–0.17), V, 0.12 (0.11–0.18), VI, 0.08 (0.06–0.08) + 0.22 (0.10–0.23); Rostral IV+V, length 0.12 (0.11–0.14), width 0.07 (0.06–0.09); hind tibia, 0.69 (0.40–0.95); metatarsomere II, 0.11 (0.10–0.12); siphunculus, 0.17 (0.13–0.26); cauda,



Figs. 5, 6. *Aphis crassicauda,* alate viviparous female, Umstead Park, Wake Co., N.C., 27 April 1960 (Smith and Tuatay), coll. 60-187, specimen no. 2 (holotype). 5, Portion of head and antenna. 6, Tip of abdomen with siphunculus and cauda.

length 0.07 (0.04–0.08), width 0.09 (0.09–0.14), and bearing 11 setae (6–19). Antennae without secondary rhinaria. Unguis more than 2× base. Note: In most apterae observed, the antennae were 6-segmented. However, some antennae appeared with only partial segmentation between antennal segment III and antennal segment IV, or, they had only 5-segmented antennae. One was 6-segmented on one side, and 5-segmented on the other side. Some apterae are small and have 5-segmented antennae.

Alate viviparous females (Figs. 5, 6).—Color of living specimens: brownish to rose color. Color of cleared specimens: dark on head, antennae, rostrum III and IV+V, thorax, and legs (except profemora which are lighter). Abdomen with lateral areas (spots), bars on dorsal abdomenal segment VI–VII–VIII; siphunculi, cauda, anal, and genital plates.

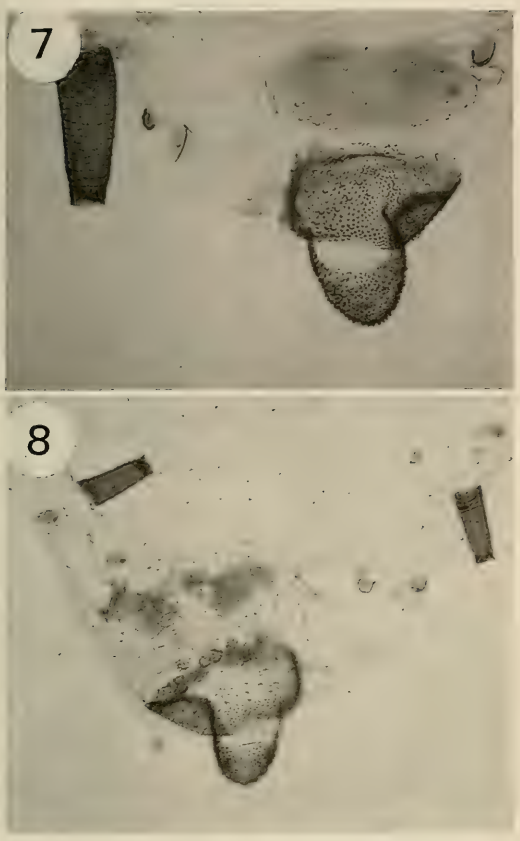
Measurements (the first measurement is that of a single specimen (60-187 #2, the holotype). The measurements in parentheses represent the range of 11 specimens). Length of body, 1.75 (1.07–1.85); width of head, 0.39 (0.38–0.42); antennal segment III, 0.31 (0.31–0.35), IV, 0.17 (0.16–0.21), V, 0.16 (0.16–0.19), VI, 0.09 (0.09–0.11) + 0.28 (0.26–0.32); rostral IV+V, length 0.13 (0.11–0.15), width 0.07 (0.05–0.10); hind tibiae, 0.90 (0.80–0.99); metatarsomere II, 0.11 (0.10–0.12); siphunculi, 0.21 (0.18–0.25); cauda, length 0.06 (0.05–0.08), width 0.10 (0.07–0.12), and bearing 14 setae (9–17). Tarsal chaetotaxy 3-3-2. Secondary rhinaria on antennal segment III, 9–10 (7–14) in nearly a straight row.

Apterous oviparous females (Fig. 8).—Color of living specimens, reddish-brown. Color of cleared specimens dusky on head; antennal segments I, II (III and IV?), distal one-half, V and VI, rostrum III, IV+V; coxae, trochanters, femora, tibiae (tip), tarsi; siphunculi; cauda, and anal plate.

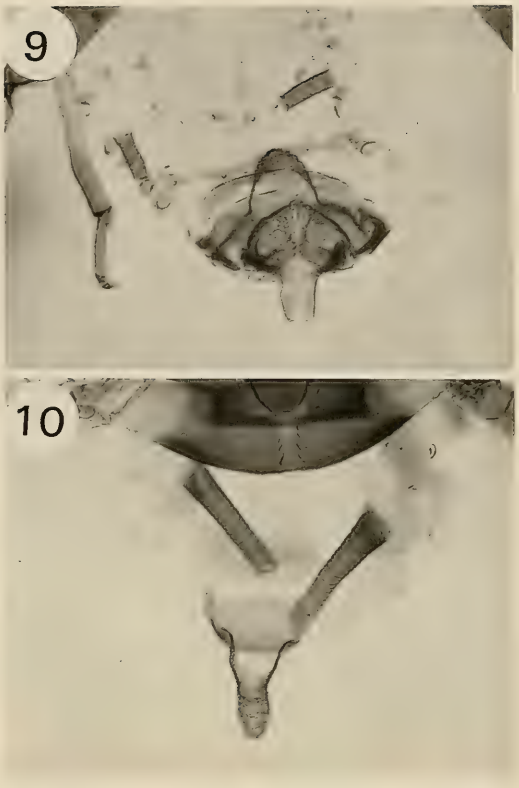
Measurements (the first measurement is that of a single specimen. Measurements in parentheses represent the range of 6 specimens). Length of body, 1.69 (1.45–1.82); width of head, 0.35 (0.32–0.40). Some specimens have 6-segmented antennae.

The following measurements are for specimens with 5-segmented antennae. Antennal segments: antennal segments III and IV appear to be fused in some specimens; III–IV, 0.29 (0.17–0.29), V, 0.14 (0.1–0.14), VI, 0.09 (0.086–0.096) + 0.25 (0.22–0.25); rostral IV+V, length 0.12 (0.11–0.12), width 0.06 (0.06–0.08); hind tibiae, 0.71 (0.62–0.71); metatarsomere II, 0.11 (0.09–0.11); siphunculi, 0.13 (0.12–0.14); cauda, length 0.07 (0.05–0.07), width 0.11 (0.09–0.11), and bearing 20 setae (20–24). Antennae without secondary rhinaria. Hind tibiae not swollen, with 0–10 pseudosensoria on distal half.

Apterous male (Fig. 9).—Color of living specimens, reddish brown. Color of cleared specimens dusky on head, antennae, legs, rostrum (especially segments III and IV+V), siphunculi, cauda, genitalia, ab-



Figs. 7, 8. *Aphis crassicauda.* 7, Fundatrix, coll. 60-26, specimen no. 6., portion of tip of abdomen with siphunculus and cauda. 8, Oviparous female, Umstead Park, Wake Co., N.C., 4 November 1959 (C. F. and C. K. Smith), coll. no. 59-1493, specimen no. 1, portion of tip of abdomen with siphunculi and cauda.



Figs. 9, 10. 9, *Aphis crassicauda,* Umstead Park, Wake Co., N.C., 4 November 1959 (C. F. and C. K. Smith), coll. 59-1483, specimen no. 2, portion of abdomen of apterous male with siphunculi, cauda, and genitalia. 10, *Aphis spiraecola,* Wilson, N.C., 27 May 1993, specimen no. 1, on *Viburnum* sp., portion of abdomen with siphunculi and cauda of alate viviparous female.

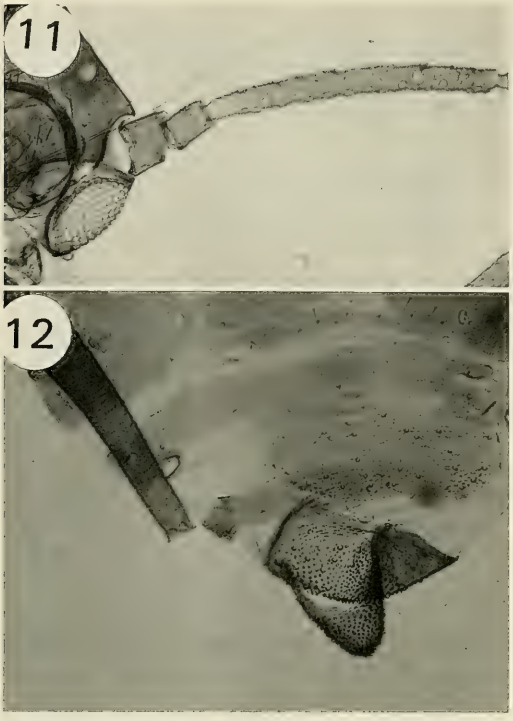
dominal segments V, VI with sclerotic area around medial setae, abdominal segments VII and VIII with dorsal bars.

Measurements (the first measurement is that of a single specimen. Measurements in parentheses represent the range of 3 specimens). Length of body, 1.35 (1.21–1.35); width of head, 0.40 (0.37–0.40); antennal segment III, 0.21 (0.21–0.25), IV, 0.14 (0.13–0.14), V, 0.14 (0.13–0.14), VI, 0.08 (0.08–0.09) + 0.21 (0.19–0.24); hind tibia, 0.63 (0.63–0.72); metatarsomere II, 0.09; siphunculi, 0.09 (0.08–0.09); cauda, length 0.06 (0.04–0.06), width 0.10 (0.08–0.10), and bearing 11 setae. Secondary rhinaria on antennal segment III, 2 (1–9), IV, 3 (3–6), V, 2 (2–3). Only 3 specimens available, one has antennal segments III and IV coalesced. Males may have pseudosensoria on distal half of hind tibiae.

Eggs.—Eggs are tan when first laid, then turn black.

Discussion.—*Aphis crassicauda* Smith and Eckel is similar to *Aphis viburniphila* Patch (1917: 416) in that the hind tibia of oviparous females not swollen, and pseudosensoria (if any) are on the distal portion.

The cauda of *A. crassicauda* is blunt or rounded (Figs. 6–8); whereas, the cauda of *A. viburniphila* Patch is more "cone-shaped" (Fig. 12).



Figs. 11, 12. *Aphis viburniphila,* alate viviparous female, coll. 64-83, Raleigh, N.C. (C. F. Smith and Hille Ris Lambers), 20 April 1964. 11, Portion of head and antenna. 12, Tip of abdomen with siphunculus and cauda.

Apterous viviparous females of *A. viburniphila* usually have secondary rhinaria on antennal segment III; whereas, they are absent on antennal segment III of apterous viviparous females of *A. crassicauda.* Alate viviparous females of *A. viburniphila* have 21–28 secondary rhinaria scattered on antennal segment III; whereas, antennal segment III of alate viviparous females of *A. crassicauda* have 7–14 secondary rhinaria in nearly a straight row.

Types.—Holotype from collection 60-187. The holotype (60-187 #2 an alate viviparous female) and some paratypes are in the National Museum of Natural History, Washington, DC. Other paratypes are in the Canadian National Collection, Ottawa; The Natural History Museum, London; North Carolina State University, Raleigh; and the collections of the authors.

Collections

(with abbreviations of morphs collected)

North Carolina (Wake Co.), Umstead State Park, type locality.

1959, coll. no. 59-77, 5 May, 3 slides (apt, al)
coll. no. 59-147, 19 May, 2 slides (apt, al)
coll. no. 59-219, 27 May, 3 slides (apt, al)
coll. no. 59-377, 4 July, 4 slides (apt)
coll. no. 59-1215, 2 Sept., 2 slides (apt)
coll. no. 59-1301, 4 Oct., 2 slides (ovip)
coll. no. 59-1369, 12 Oct., 7 slides (ovip)
coll. no. 59-1432, 22 Oct., 4 slides (ovip)
coll. no. 59-1493, 4 Nov., 4 slides (ovip, male)

1960, coll. no. 60-20, 15 April, 2 slides (ny)
coll. no. 60-26, 16 April, 12 slides (fund)
coll. no. 60-185, 4 April, 4 slides (fund)
coll. no. 60-187, 17 April, 4 slides (1 alatoid ny, fund, al)
coll. no. 60-1054, 11 Sept., 4 slides (apt, ovip)
coll. no. 60-1132, 12 Oct., 4 slides (ovip)
coll. no. 60-1194, 26 Oct., 4 slides (ovip, male)

1961, coll. no. 61-13, 3 May, 1 slide (al, apt)
coll. no. 61-32, 25 May, 1 slide (apt)
coll. no. 61-198, 6 Sept., 1 slide (apt, ovip)

1979, coll. no. 79-3, 1 April, 6 slides (fund, al)

North Carolina (Orange Co.)

1961, coll. 61-280, 25 Sept., 4 slides (apt, al) on *Viburnum*

Illinois, Starved Rock State Park

1960, coll. 60-583, 4 slides on *Viburnum*

Pennsylvania, Phillipsburg

1961, coll. no. 61-280, 4 slides on *Viburnum*

Summary of Dates of Collection of Different Morphs in Umstead Park

ny = nymphs only: 15 April
fund = fundatrices, 16 and 17 April
al = alate viviparous females: 17 April to 27 May
apt = apterous viviparous females: 5 May to 11 Sept.
ovip = apterous oviparous females: 11 Sept. to 4 Nov.
male = apterous males: 26 Oct.

Key to Alate Viviparous *Aphis* spp. on *Viburnum* spp. in North America

1 Cauda with 10 or more setae. Abdomen without a dark, dorsal patch, may have transverse dark bars 2
1′ Cauda with 5–6 setae. Abdomen with a dark, dorsal patch (Figs. 1, 2) . . . . . *Aphis viburnicola* Gillette
2(1) Cauda not longer than broad (Caudal length and width in key refers to length on median line of sclerotic or hard portion and width at base (center) of this portion.) 3
2′ Cauda longer than broad 4
3(2) Abdomen with dorsal transverse bars on segments I–VIII. Lateral tubercles conspicuous on segments I–VII (Figs. 3, 4) (see Smith and Parron 1978:47) . . . . . *Aphis viburni* Scopoli
3′ Abdomen without dorsal transverse bars on segments I–V (may have indications of bars). Lateral tubercles not conspicuous on segments II–VI (Figs. 5–9) . . . . . *Aphis crassicauda,* n. sp.
4(2′) Unguis equal to or longer than antennal segment III 5
4′ Unguis usually distinctly shorter than antennal segment III (Figs. 11, 12) . . . . . *Aphis viburniphila* Patch
5(4) Secondary rhinaria not more than 10 (4–10) on antennal segment III (Fig. 10) . . . . . *Aphis spiraecola* Patch
5′ Secondary rhinaria more than 10 (12–19) on antennal segment III (Fig. 3) . . . . . *Aphis viburni* Scopoli

Acknowledgments

We thank the North Carolina Department of Natural Resources and Community Development and the North Carolina Division of Parks and Recreation for permission to collect aphids and specimens of host plants for research.

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NOTES ON NEARCTIC *BIBIO* (DIPTERA: BIBIONIDAE)

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Abstract.—*Bibio macateei* James is a new junior subjective synonym of *B. fumipennis* Walker, not a junior subjective synonym of *B. xanthopus* Wiedemann. *Bibio melanopilosus* Hardy and *B. kansensis* James are new junior subjective synonyms of *B. curtipes* James, and a redescription of the intraspecific color variation of this species is given. ***Bibio autumnalis,*** n. sp., is described from a holotype male and one female and seven male paratypes from Utah, and is distinguished from the similar *B. flukei* Hardy by the structure of the epandrium and gonostylus of the male. Both the male postabdomen of *B. autumnalis* and *B. flukei* are illustrated for comparison.

Key Words: *Bibio,* North America, new synonymy, new species

Bibio is the largest genus of North American Bibionidae and can be distinguished by the strong development of the foretibial spurs and the presence of a radial-medial crossvein separating veins R_{4+5}, and M. Hardy (1945) provided the most recent revision of the Nearctic species of *Bibio.* Presently, 53 species and one subspecies are recognized (Hardy 1981).

A review of the North American *Bibio* has indicated one new species and several new synonyms. The terminology follows Hardy (1981). Acronyms for the depositories of specimens are as follows: American Museum of Natural History (AMNH); The Natural History Museum (BMNH); Brigham Young University, Monte L. Bean Life Science Museum (BYU); Museum of Comparative Zoology, Harvard University (MCZ); Canadian National Collection, Ottawa (CNC); Colorado State University, C.P. Gillette Museum of Arthropod Diversity (CSU); University of Colorado Museum (CU); and University of Guelph (DEBU).

Bibio fumipennis Walker

Bibio fumipennis Walker 1848: 122. Holotype male (BMNH), Canada: Ontario, Hudson Bay, Albany River, St. Martin Falls.

Bibio inaequalis Loew 1864: 51. Type series (MCZ), USA: Alaska, Sitka. Synonymized by Hardy (1956).

Bibio simplicis Curran 1923: 245. Holotype male (CNC), Canada: Alberta, Nordegg. Synonymized with *B. inaequalis,* Hardy (1945).

Bibio macateei James 1936: 4. Holotype female (AMNH), USA: Colorado, Rocky Mountain National Park, Trail Ridge Road, 12,000′; examined. **New synonymy.**

In 1936, James described *Bibio macateei* noting the possibility that it might be a junior synonym of *Bibio humeralis* Walker. Hardy (1945) placed both *B. humeralis* and *B. macateei* as junior subjective synonyms of *Bibio xanthopus* Wiedemann.

Examination of the holotype female, al-

lotype male and paratypes of *Bibio macateei,* indicates that this species is not a junior subjective synonym of *B. xanthopus,* but rather a junior subjective synonym of *B. fumipennis.* In the description of *B. macateei,* James states that the hind basitarsus of the male is "slightly enlarged, but cylindrical" (James 1936), whereas Hardy's redescription of *B. xanthopus* states that the "hind metatarsi (are) not swollen" (Hardy 1945). The hind basitarsus of *B. macateei* is clearly swollen in comparison to the slender hind basitarsus of *B. xanthopus.* At the time of James' description of *B. macateei,* which is based upon a female holotype, the female of *B. fumipennis* was unknown. Collections of males and females of *B. fumipennis,* some identified by Hardy, were compared with types of *B. macateei* and found to be conspecific. Several specimens identified as *B. fumipennis* by Hardy were collected within 23 km of the type locality of *B. macateei.*

The following records are representative of some of the specimens examined.

CANADA: ALBERTA.: Livingstone Falls Camp, 2 males (DEBU); BRITISH COLUMBIA: Pink Mtn.: cow parsnip, 1 male (DEBU); cold bare tundra, 1 male (DEBU); NEWFOUNDLAND., Shoal Cove Rd., 7 males, 3 females (DEBU); USA: ALASKA: Unalakleet, 1 male (DEBU); COLORADO: Boulder Co.: Green Lakes, 14 Aug. 1990, B. Kondratieff, 3 males, 1 female (CSU); Niwot Ridge, alpine zone, 2 Aug. 1961, S. C. Johonnott, 1 male (CU); Hinsdale Co.: Matterhorn Creek, 13 Aug. 1992, S. Fitzgerald, 1 male (CSU); Red Cloud, Silver Creek: 5 Sept. 1993, A. Siedl, 1 male (CSU); 1 Aug. 1992, B. Kondratieff, 3 males (CSU); Larimer Co.: 3 Aug. 1988, B. Kondratieff, 1 male (CSU); Pingree Park, 17-22 Aug. 1925, 1 male, 1 female (BYU); Cameron Pass, 20 Aug. 1941, Vasco M. Tanner, 2 males, 1 female (BYU); Estes Park: 3 males (CSU); Lake Odessa, 1 male, 1 female (CSU); WYOMING: Centennial, 1 male (CSU).

Bibio curtipes James

Bibio curtipes James 1936: 6. Holotype female (AMNH), USA: Colorado, Boulder; examined.

Bibio kansensis James 1936: 6. Holotype female (AMNH), USA: Kansas, Kirwin; examined. **New synonymy.**

Bibio melanopilosus Hardy 1936: 195. Holotype male (BYU), USA: Utah, Spanish Fork. **New synonymy.**

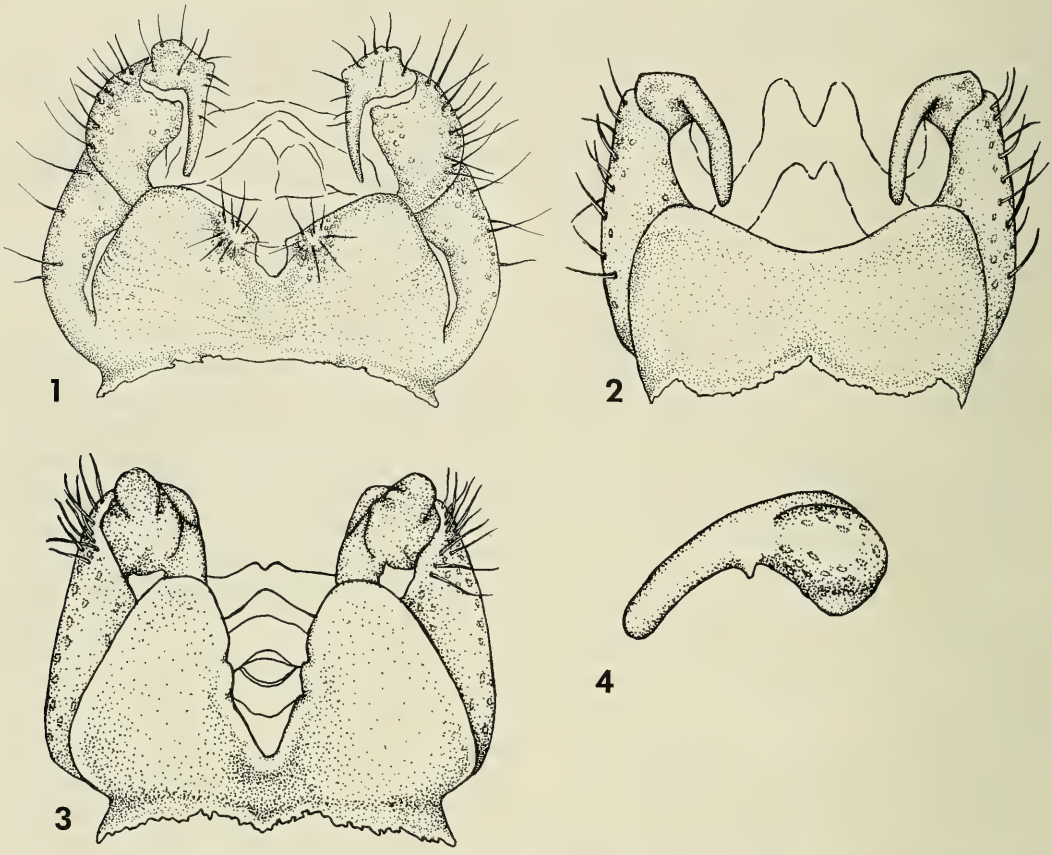
Four species of North American *Bibio, B. albipennis* Say, *B. curtipes* James, *B. kansensis* James, and *B. melanopilosus* Hardy, have the combination of the inner spur of the foretibia short and the radial-medial crossvein one-third to one-fourth the length of the basal part of the radial sector. *Bibio albipennis* is one of the most common and widespread species in North America (Hardy 1945). The other three species of this group are supposedly separable by the length of the hind basitarsus and the relative coloration of the legs and thoracic pile (Hardy 1945). A review of the type material of all three species, and especially the male terminalia indicates the presence of just a single variable species, with *B. curtipes* having priority.

Leg color in types of the three species is very similar, and the pile color varied among series of specimens from single localities. The minor differences in the length of the hind basitarsus of the three species are not considered of specific importance.

The development of two "nipples" on the posterior edge of the epandrium of male *B. curtipes* (Fig. 1) is distinctive and also present in types of both synonyms. The distinctive epandrium in combination with the short radial-medial crossvein and short inner spur of the foretibia will easily distinguish this species from all other North American species.

A redescription of *B. curtipes* is given, including intraspecific color variation of the legs and thoracic pile, and the male postabdomen figured.

Male: Thorax and abdomen brown to



Figs. 1–4. Male postabdomen, dorsal view. 1, *Bibio curtipes.* 2, *Bibio autumnalis.* 3, *Bibio flukei.* 4, *Bibio flukei,* gonostylus removed to indicate basal tooth.

black, dorsum of thorax and head black. Pile yellow to brown to black and sometimes intermixed on dorsum of thorax, tibia and tarsi. Pile of abdomen sometimes white to grey. Halter brown. Inner spur of fore tibia one third to one fourth length of outer. All legs rufous to brown, with hind femur sometimes slightly darker than tibia and tarsi. Hind basitarsus not swollen, one and one half to two times as long as the preceding segment; these preceding segments short and stout. Hind tibial spurs broad and rounded. All femora and hind tibia clavate. Wing 3.5–6 mm. Anterior veins and stigma brown, posterior veins translucent light brown. Wing hyaline to slightly brown fumose, more so costally. Radial-medial crossvein one third to one fourth the length of the basal part of the radial sector. Epandrium with two posteromedial "nipples" which lie, one on each side, of the posteromedial cleft as Fig. 1. Gonocoxite near the attachment to the gonostylus, convex, robust; Gonostylus, simple, digitiform (Fig. 1).

In addition to examination of the holotype, allotype, and two paratypes of *B. curtipes,* the holotype, allotype, and twenty-one paratypes of *B. kansensis,* and ten paratypes of *B. melanopilosus,* the following records are representative of some of the specimens examined: COLORADO: Denver Co., 10 May 1939, M. T. James, 31 males, 33 females (CSU); Larimer Co., ARDEC farm, 8 May 1994, S. Fitzgerald, 1 male (CSU).

Bibio autumnalis Fitzgerald
New Species
(Fig. 2)

A new species of *Bibio* from Utah was found among material submitted for identification by Dr. Richard W. Baumann, Brigham Young University. These specimens are similar in general habitus to *B. flukei* Hardy, which is recorded from the montane and subalpine zones of the southern Rocky Mountains.

Holotype male: (BYU), Utah, Utah Co., Squaw Peak Trail Road, 3 miles south Provo Canyon, malaise trap, 2–14 September 1985, C. R. Nelson.

Paratypes: Utah, Utah Co., Squaw Peak Trail Road, 3 miles south Provo Canyon, malaise trap, 2–14 September 1985, C. R. Nelson, 3 males, 1 female (2 CSU, 2 BYU); Utah, Iron Co., Cedar Canyon Campground, Hwy 14, 9 October 1983, R. W. Baumann and C. R. Nelson, 1 male (BYU); Utah, Garfield Co., Mammoth Spring, 9 Oct. 1983, R. W. Baumann and M. Whiting, 1 male (BYU); Utah, Kane Co., Hwy 14 near Aspen Mirror Lake, Duck Creek, 9 October 1983, R. W. Baumann and C. R. Nelson, 2 males (BYU).

Diagnosis.—*Bibio autumnalis* may be separated from the similar *B. flukei* by the following characters: In dorsal view, the epandrium of *B. autumnalis* is cleft about one-fourth its length (Fig. 2), whereas the cleft in the epandrium of *B. flukei* is about two-thirds the length (Fig. 3). Additionally, the male gonostylus of *B. autumnalis* (Fig. 2) lacks a distinct basal tooth that *B. flukei* possesses (Fig. 4). *Bibio autumnalis* may also be separated from *B. flukei* by wing length; 4 mm in *B. autumnalis* and 6-6.5 mm in *B. flukei.*

Male.—Thorax and abdomen primarily shining brown. Dorsum of thorax and head shining black except humeral ridge sometimes pale. Pile of head long, copious, black beneath, that of eye, palpus, and antenna short red-yellow erect. Palpus five segmented, third segment thickened. Antenna seven segmented, seventh segment one and one half to two times as long as preceding segments. Halter yellow-brown to black. Pile of legs, body and abdomen yellow-red, that of tibia and tarsi shorter. Fore and mid legs brown, except fore tibial spurs yellow with dark tip. Inner spur very short; one fourth to one third the length of the outer. Hind femur brown usually with basal constriction yellow. Hind tibia light brown or rufous, tipped with brown basally and apically, but always more pale than hind femur. Hind tibial spurs apically acute. Hind basitarsus distinctly swollen and globular, about two and one-half to three times as long as wide, concolorous with the tibia. All femora and hind tibia clavate. Hind tibia greatly dilated distally. Wing hyaline, stigma and anterior veins light brown yellow, and posterior veins slightly yellowed. Costa setulose and terminating at or just beyond meeting R_{4+5}. R_1 indistinctly meeting or evanescent before termination in costa. Radial-medial crossvein slightly longer than basal portion of radial sector. Bm-cu very indistinct. Membrane with microtrichia. Wing length 4 mm. Cleft in epandrium about one-fourth its length, gonostylus lacking a basal tooth. Postabdomen as Fig. 2.

Female.—Thorax yellow-orange except three black vittae on dorsum. Head and antenna black except pedicel and scape yellow. Legs yellow-orange except darkened apical tarsal segments. Posterior basitarsus long and slender, not swollen. Posterior tibial spurs apically acute. Wings slightly yellow-brown fumose, 5.25 mm.

Remarks.—*Bibio autumnalis* is most similar in general habitus to *B. flukei* and will key to this species in Hardy (1945). However, *B. autumnalis* is probably more closely related to other fall emerging species, *B. longipes* Loew and *B. slossonae* Cockerell. The smaller size and yellow legs of the male will easily distinguish *B. autumnalis* from the above species.

Presently *B. autumnalis* appears to be restricted to Utah, although it is probable that

it may also occur in similar Great Basin and Colorado Plateau habitats.

Bibio flukei Hardy

Bibio flukei Hardy 1937: 202. Holotype male (AMNH), USA: Colorado, Cameron Pass; examined.

Bibio flukei appears to be restricted to the montane and subalpine zones of the southern Rocky Mountains between elevations of about 2700–3440 m. The following records are representative of some of the specimens examined: COLORADO: Larimer Co.: Chambers Lake, 14 Aug. 1946, M. T. James, 12 males, 1 female (CSU); Pingree Park, 21 Aug. 1935, D. A. Wilbur, 5 males (CSU); Stormy Peak, 11,000′, 17 Aug. 1932, M. T. James, 2 males (CSU); West Branch Larimie River, 22 Aug. 1993, S. Fitzgerald, 1 male (CSU); Jackson Co., Gould near Cameron Pass, 19–21 Aug. 1940, M. T. James, 1 male (CSU); Boulder Co.: Aug. 1939, Hugo G. Rodeck, 1 male (CU); near science lodge, 18 Aug. 1939, U. N. Lanham, 1 male (CU); Hinsdale Co., Cooper Creek, 8 Aug. 1993, S. Fitzgerald, 2 males (CSU).

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REVISION OF THE SOUTH AMERICAN THYNNINE GENUS *UPA* (HYMENOPTERA: TIPHIIDAE)

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Abstract.—Six new species of the tiphiid genus Upa are described: ***U. bidentata***, ***U. ligulata***, ***U. longispina***, ***U. nasata***, ***U. porteri***, and ***U. tridentata.*** All these species are from Brazil, except *U. porteri* which is from Argentina. A distribution map, figures, and a key to males of all seven described species are given.

Key Words: Tiphiidae, Thynninae, *Upa*

The genus *Upa* was originally described by Kimsey (Genise and Kimsey 1991), based on the Brazilian species *Scotaena impressiceps* Turner. More recently specimens borrowed from several collections have revealed six previously undescribed species that belong to this genus. Very little is known about the genus *Upa*: females are known only for two species (*impressiceps* and *porteri*) and the biology of this group is completely unknown. Based on collection data for the new species it is clear that these wasps occur in some of the more ancient landscapes in South America, particularly in the Brazilian highlands. They are distributed from Misiones, Argentina, and southeastern Paraguay, east to Brazil, in the states of Santa Catarina, Paraná, Rio de Janeiro, Minas Gerais and Bahia (Fig. 1), and Rio Grande do Sul.

Certain morphological features used in this study need to be clarified. Coloration is useful taxonomically only in overall pattern, precise color markings vary slightly from specimen to specimen, with certain some individuals having the yellow markings smaller or muddier than others. In descriptions of punctuation below, punctures should be assumed to be circular in outline unless otherwise stated. Finally, flagellar dimensions are measured using the length of the medial axis and breadth of the apex of each flagellomere.

Specimens were borrowed from the following collections and individuals: COLLEGE STATION—Texas A&M University, College Station, U.S.A. (R. Wharton, J. Woolley); COPENHAGEN—Zoologisk Museum, Copenhagen, Denmark (B. Peterson); DAVIS—Bohart Museum of Entomology, University of California, Davis, U.S.A. (S. L. Heydon); GAINESVILLE—Florida State Collection of Arthropods, Gainesville (L. A. Stange); LONDON—The Natural History Museum, London, England (M. Fitton); LOS ANGELES—Los Angeles County Museum; Los Angeles, California, U.S.A. (R. R. Snelling); OTTAWA—Canadian National Insect Collection, Agriculture Canada, Ottawa, Ontario, Canada (L. Masner); PITTSBURGH—Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A. (J. Rawlins); SÃO PAULO—Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (C. R. F. Brandão). Type repositories of specimens discussed below are indicated by the city name of the collection given in capital letters and enclosed in parentheses. Additionally, "PD" is used as an abbreviation

Fig. 1. Distribution map of *Upa* species.

for puncture diameter when discussing relative densities of integumental punctation.

Key to the Males of Species of *Upa*

1. Clypeus gently convex, flat or slightly concave between dorsal margin and trilobate apical margin, without additional projections or lobes (as in Fig. 5); propodeum highly polished and sparsely punctate 2
– Clypeus with one or more submedial lobes or projections between dorsal margin and trilobate apical margin (as in Figs. 2, 3, 6); propodeum densely punctate, appearing rough, punctures separated by one PD or less 3
2. Abdomen without transverse yellow or orange bands beyond basal tergum; propodeum with small ovoid yellow lateral spot; aedeagus with greatly elongate ventral lobe extending further than paramere . . . . . *longispina*
– Abdomen with three or more terga with transverse yellow or orange bands; propodeum with large U-shaped yellow spot; aedeagus with ventral lobe extending only as far as apex of paramere (Fig. 13) . . . . . *tridentata*
3. Clypeus with single submedial projection (Fig. 3); vertex greatly expanded beyond hindocelli, posterior margin separated from hindocelli by at least 2 midocellus diameters (Fig. 3); hypopygium ligulate, without apicomedial emargination and not apically bidentate (as in Fig. 8) . . . . . *ligulata*
– Clypeus with two submedial or subapical projections or lobes (Figs. 2, 6); vertex not unusually expanded posteriorly, posterior margin separated from hindocelli by less than 1.5 midocellus diameters; hypopygium usually apicomedially emarginate or apically bidentate (as in Fig. 9) 4
4. Clypeus with submedial projections located close together and just above apical margin, apical margin with large rounded medial lobe (Fig. 6) . . . . . *nasuta*

– Clypeus with submedial projections broadly separated, apical margin with three subequal lobes or teeth (as in Fig. 2) 5
5. Hypopygium apically rounded, not emarginate or dentate (Fig. 8); aedeagus with ventral and dorsal lobes well-developed (Fig. 15) .. *bidentata*
– Hypopygium apically emarginate or bidentate (as in Fig. 9); aedeagus with ventral lobe highly reduced or absent, dorsal lobes small and digitate (Fig. 14) 6
6. Epipygium lateral carinae not protruding dorsally, dorsal surface appearing essentially flat; parameres relatively flat, not cupping aedeagus (Fig. 17) ..... *porteri*
– Epipygium lateral carinae strongly protruding dorsally, and dorsal surface appearing concave as a result; parameres strongly curved around aedeagus (Fig. 18) ..... *impressiceps*

Upa bidentata Kimsey, New Species
(Figs. 1, 8, 12, 15)

Description.—Male (holotype): Body length 11 mm; forewing length 10 mm; facial and scutal punctures small and contiguous; clypeus apically trilobate, with two widely separated medial projections; flagellomere I twice as long as broad; flagellomere II 2.5× as long as broad; pronotal and scutellar punctures 1–3 PD apart; vertex unmodified; mesopleural punctures 0.5–1 PD apart; propodeal punctures laterally contiguous to 0.5–1 PD medially, punctures transversely striatiform, with impunctate triangular dorsomedial area; tergum I highly polished, punctures 3–5 PD apart; terga II–VI punctures 0.5–1 PD apart; epipygium apically truncate, medially slightly concave; hypopygium ligulate, apically rounded (Fig. 8); genital capsule (Fig. 15): paramere submedially curved and strongly tapered apically (Fig. 12); aedeagus with small dorsal lobe before apical loop and ventral lobes large and broad. Coloration black, with yellow markings; clypeus yellow except dorsal margin and apical rim; lower eye margins and top of eye yellow; antennal lobes yellow; vertex with sublateral yellow bands; pronotum with anterior carina yellow, yellow lateral spot and transverse lateral yellow band adjacent to tegula; tegula anteriorly yellow; scutum with two small posteromedial yellow spots and lateral margin yellow; mesopleuron with dorsal and medial yellow spots; scutellar medial and anterolateral spots yellow; metanotal medial and anterolateral spots yellow; propodeum with large sublateral yellow band; fore- and midcoxae anteriorly yellow; hindcoxae with ventral and dorsal yellow bands; fore- and midfemur ventrally yellow; hindfemur ventrally yellow grading to orange laterally and apically, and dark brown basally; foretibial outer surface yellow; rest of legs orange; sternum I with symmetrically lobate medial yellow spot; tergum I lateral margin and posterior bat-shaped bands yellow; segments II–IV with anterior brown band, submedial yellow one with widely separated dark brown spots embedded in posterior margin, followed by narrower brown band; segments V–VII dark brown. Wing veins orange, membrane yellow.

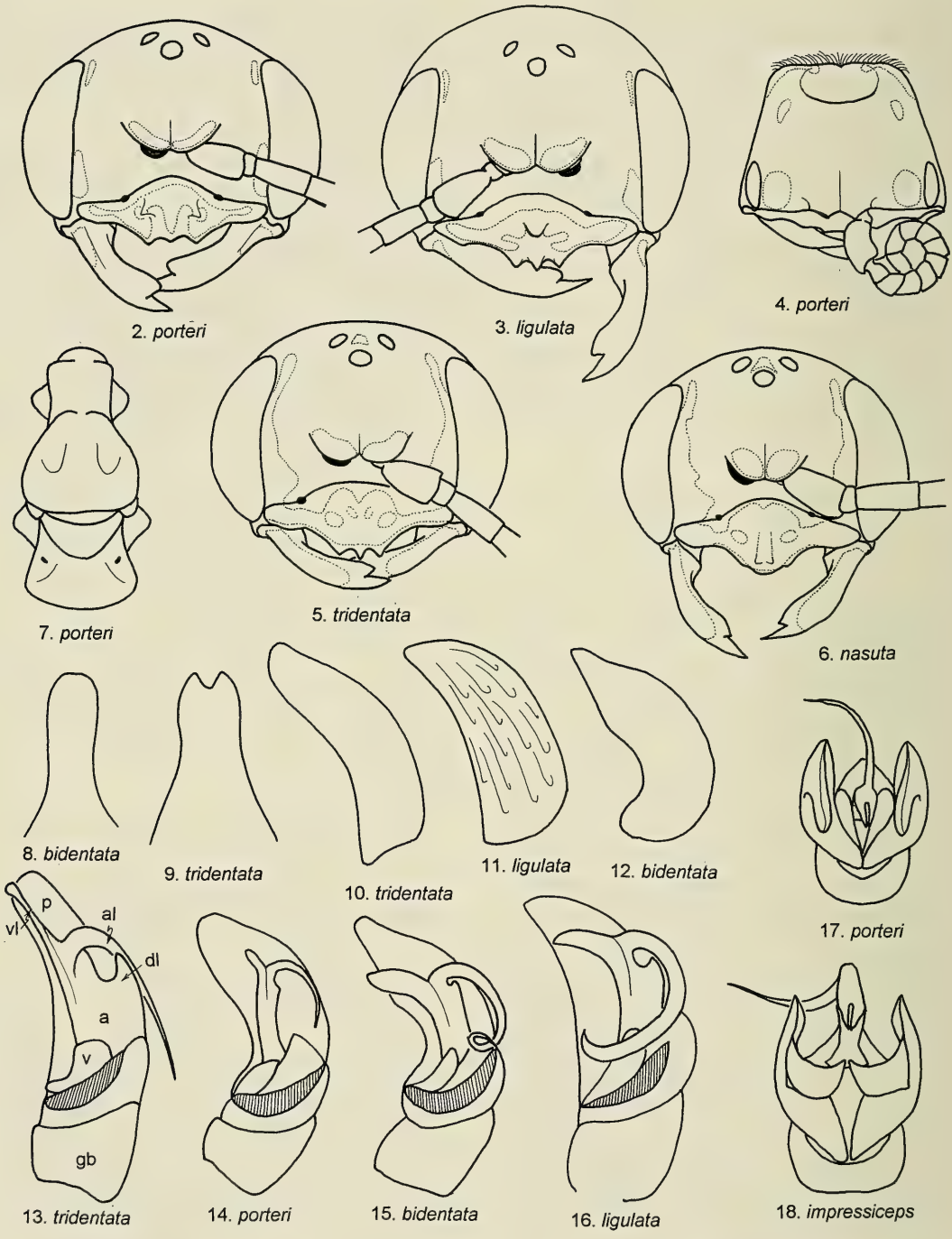
Paratype males vary slightly in extent of yellow marks, particularly on clypeus and propodeum, and orange markings on terga II–IV, body length, 11–13 mm, and forewing length, 8–10 mm.

Female unknown.

Type material.—Holotype, male, BRAZIL: Santa Catarina, Nova Teutonia, Oct. 1964, F. Plaumann (SÃO PAULO). The holotype is missing one ultimate hindtarsomere, and the flagellum is broken off and glued to the side of the pin. Paratypes: 2 males, same data as type, except Oct. 1935 (LONDON), 1 male, Feb. 1937 (LONDON), 1 male, Sept. 1968 (DAVIS), 1 male, no date (DAVIS); 1 male: Paraná, Curitiba, 4 Jan. 1937, C. Westerman (SÃO PAULO).

Etymology.—The species name refers to the two medial projections on the male clypeus.

Discussion.—Superficially this species strongly resembles *porteri* and *impressiceps*; all have the same bilobate, medial clypeal projection, and overall coloration. However, *bidentata* differs from these species by the ligulate hypopygium (similar to



Figs. 2–18. Details of species in the genus *Upa*. 2, 3, 5, 6, Front view of male face, with one antenna removed. 4, Front view of female face, with one antenna removed. 7, Dorsal view of female thorax, with head (top), legs, and abdomen (bottom) removed. 8, 9, Apex of hypopygium. 10–12, External view of paramere. 13–16, Lateral view of genital capsule, with closest paramere removed. Abbreviations: a = aedeagus, al = apical loop, dl = dorsal lobe, vl = ventral lobe; gb = gonobase; p = paramere; v = volsella. 17, 18. Dorsal view of genital capsule.

that of *ligulata*); short aedeagal column (only about half as long as the paramere); well-developed dorsal aedeagal lobe; and greatly elongate ventral lobes. *Upa porteri* and *impressiceps* both have the aedeagal column more than half as long as the paramere, short ventral aedeagal lobes and reduced or absent dorsal ones.

Upa ligulata Kimsey, New Species
(Figs. 1, 3, 11, 16)

Description.—Male (holotype): Body length 12 mm; forewing length 10 mm. Face (Fig. 3), punctures nearly contiguous, except on clypeus; clypeus with conical medial projection, narrowly trilobate apically, punctures 1–2 PD apart except for impunctate medial band; vertex greatly expanded behind hindocelli, posterior margin more than 1.5 midocellus diameters beyond hindocelli in frontal view; flagellomere I twice as long as broad, flagellomere II 2.3× as long as broad; head densely punctate with small, deep, nearly contiguous punctures; thoracic punctures small but generally 0.5 PD apart; propodeal punctures nearly contiguous; abdominal punctures becoming denser toward apex, tergum I punctures 1–2 PD apart, tergum V punctures nearly contiguous; hypopygium ligulate, apically without emargination or angles; genital capsule (Fig. 16): paramere slightly curved and coarsely sculptured externally (Fig. 11); aedeagus with large dorsal lobe before apical loop and ventral lobes long and lanceolate. Coloration: body, including antenna, black with yellow on: antennal lobes, lower eye margin yellow, small yellow spot on upper eye margin, mandibular base yellow; clypeus ventral half yellow except medially, vertex with lateral yellow stripe, pronotum with transverse anterior yellow stripe, transverse sublateral one, and lateral yellow spot; tegula medially yellow; scutum with two small posterolateral yellow spots; scutellum medially yellow; metanotum medially and laterally yellow; forefemur apicoventrally yellow; midfemur with narrow ventral yellow stripe; terga I–IV with subapical transverse yellow band broken medially, width of break increasing posteriorly, on tergum IV band halves separated by their length; sterna II–III with small posterolateral yellow spot. Wings with orange veins; membrane yellow-tinted, darkest in costal and marginal cells.

Female unknown.

Type material.—Holotype, male, BRAZIL: Rio Grande do Sul, Arroio Arapua, 19 Dec. 1964, F. Plaumann (DAVIS). The holotype has 6 flagellomeres missing on one antenna.

Etymology.—The name refers to the ligulate hypopygium.

Discussion.—The most distinctive features of this species are the clypeus with a single medial projection, the expanded vertex, and the aedeagus with well-developed dorsal and ventral lobes. In addition, an unusual feature of *ligulata* is the sculpturing of the external surface of the paramere, which is irregularly longitudinally grooved with associated punctures. There is some similarity between *ligulata* and *bidentata* based on the configuration of the clypeus, ligulate hypopygium, and aedeagus. *U. ligulata* differs considerably from other species of *Upa* due to the medially unilobate clypeus, expanded vertex, and subtriangular and sculptured parameres.

Upa longispina Kimsey, New Species
(Fig. 1)

Description.—Male (holotype): Body length 14 mm; forewing length 12 mm. Head with small, deep contiguous punctures; clypeus slightly concave in lateral view, apical margin tridentate; flagellomere I length 2.4× breadth; flagellomere II 2.8× as long as broad; vertex unmodified; pronotum impunctate medially, dorsolaterally punctures 1–3 PD apart; rest of thoracic notal punctation, including propodeum, 0.5–1 PD apart; propodeal punctures transversely striatiform; tergum I punctures shallow and elongate, widely separated and 1–5 PD

apart; tergum II punctures shallow and contiguous to 0.5 PD apart; terga III–V with shallow, elongate contiguous punctures; terga VI–VII punctures shallow, elongate and 0.5–1 PD apart, nearly impunctate medially; epipygium apically rounded; hypopygium apicolaterally rounded and apically emarginate; genital capsule: paramere slender, curved and essentially parallel-sided until abruptly tapered apically; aedeagal column short, dorsal lobe originating at middle of paramere, ventral lobe very slender and elongate, extending about half of length beyond apex of paramere. Color black, with yellow on: clypeus, except medially, and dorsal and apical margins yellow; antennal lobes yellow; inner and outer eye margins yellow; yellow between ocelli; mandible medially yellow; transverse band across vertex and along gena yellow; pronotum with transverse yellow band on posterior margin; scutal lateral margin yellow; scutellum anterolaterally yellow, with two small medial yellow spots; metanotum medially and anterolaterally yellow; mesopleuron with small dorsal and medial yellow spots; propodeum with small sublateral yellow spot and yellow spot anterior to spiracle; fore- and midcoxae anteriorly yellow, hindcoxa with small yellow dorsal stripe; terga and sterna III–IV with small anterolateral yellow spot; tergum I with thin posterior yellowish orange line, tergum II posteromedially yellowish orange; sterna I–II medially yellowish orange; femora dark brown shading to orange and yellow; tibiae and tarsi orange; tegula brown. Wing veins brown; membrane yellow.

Female unknown.

Etymology.—The species name refers to the elongate ventral lobes of the aedeagus.

Type material.—Holotype, male, BRAZIL: São Paulo, H. Florestal, J. Land (SÃO PAULO). The holotype is missing: one ultimate midtarsomere, one antenna and the apical flagellomere on the other antenna. Paratype, 1 male, São Paulo, Cantareira, Coher (DAVIS).

Discussion.—*Upa longispina* is another species without medial clypeal lobes or projections, and is probably most closely related to *tridentata.* It can be distinguished from that species by the darker coloration (having little or no pale banding on the terga), and the propodeal markings restricted to a small yellow spot. In addition, the ventral aedeagal lobes are apically acute and not capitate, protruding well beyond the apex of the parameres.

Upa nasuta Kimsey, New Species
(Figs. 1, 6)

Description.—Male (holotype): Body length 12 mm; forewing length 10 mm. Face (Fig. 6), punctation contiguous, small and deep, only slightly less dense on gena and clypeus; clypeal apex weakly trilobate, with projecting medial ridge terminating in bidentate apex just above clypeal apex; flagellomere I 2.4× as long as broad; flagellomere II length 2.9× breadth; vertex unmodified pronotal punctures 1–3 PD apart; scutal punctures 0–1 PD apart; scutellar punctures 2–3 PD apart; propodeal punctures 1–2 PD apart with impunctate medial stripe; tergum I nearly impunctate, punctures 3–6 PD apart; tergum II punctures elongate and 1 PD apart; terga III–V punctures 0.5 PD apart; terga VI–VII punctures shallow and elongate, 0.2–0.5 PD part; tergum VII with broadly impunctate medial stripe; epipygium apically slightly rounded; hypopygium apically linear with apicomedial emargination; genital capsule similar to *tridentata* (as in Fig. 13). Body black with yellow on: clypeus, except ventral and dorsal margins; mandible medially yellow; antennal lobes yellow; inner eye margin yellow, with yellow line around gena and postvertex; pronotum anterior and posterior margins (broken medially), and laterally yellow; propleuron medially yellow; mesopleuron medially yellow; scutal posteromedial spot and two spots on lateral margin yellow; scutellum medially and anterolaterally yellow; propodeum with large U-shaped yellow mark extending from spira-

cle to hindcoxa and two submedial oblique yellow lines; terga I–V transverse posterior yellow band, broken medially, with inset dark transverse spot sublaterally; tergum I with yellow lateral line; segments VI–VIII black; sternum I, yellow except laterally and orange posteriorly; sterna II–IV yellow, except posteromedially black and orange peripherally; fore and midcoxae anteriorly yellow; hindcoxa with two oblique dorsal stripes yellow; femora ventrally yellow; tibiae and tarsi yellowish orange yellow; tegula transparent yellowish brown; flagellum reddish orange ventrally. Wing veins yellowish brown; membrane slightly tinted.

Paratype males: vary in body length 11–14 mm, forewing length 9–11 mm; and extent of yellow markings, with the medial yellow spots on the scutum and scutellum often reduced or absent; clypeal projection can be strongly bituberculate or almost apically truncate, the apical clypeal margin with strong medial lobe and almost no submedial ones, or clearly trilobate.

Female unknown.

Type material.—Holotype, male, BRAZIL: São Paulo, Serra da Bocâina, S. J. Barreiros, 13–17 Jan. 1969, Porter and Garcia (DAVIS). The holotype is missing the apical four tarsomeres on one midleg. Paratypes: 17 males, same data as type (DAVIS, SÃO PAULO).

Etymology.—This species name refers to the nose-like clypeal projection.

Discussion.—Several features of this species are unusual and diagnostic, including the bicolored flagellum, and apically bilobate medial projection on the clypeus. The male genital capsule closely resembles that of *tridentata* with elongate and somewhat capitate ventral aedeagal lobes and hook-like dorsal lobe.

Upa porteri Kimsey, New Species

(Figs. 1, 2, 4, 7, 14, 17)

Description.—Male (holotype): Body length 11 mm; forewing length 9.5 mm. Face (Fig. 2), punctures deep, small and contiguous; clypeus apically trilobate, medially with two widely separated projections; flagellomeres I and II length 2.6× breadth; vertex unmofied; pronotal punctures 1–2 PD apart laterally, impunctate medially; scutal punctures 0–0.5 PD apart; mesopleural punctures contiguous; scutellar punctures 0.5–1 PD apart, impunctate medially; propodeal punctures contiguous and transversely striatiform, with impunctate anteromedial triangular area; tergum I punctures shallow and 1–3 PD apart; terga II–VI punctures 0.5 PD apart; tergum VII punctures large, shallow, elongate and 0.5 PD apart, impunctate medially; epipygium apically subtruncate; hypopygium apically medially notched or bidentate; genital capsule (Fig. 14): paramere curved and apically tapering in lateral view, inner surface only slightly curved around aedeagus (Fig. 17); aedeagus elongate and slender with small angle before short apical loop, ventral lobes short and apically rounded. Coloration: body black with yellow on: clypeus, except dorsal and ventral margins and with two yellow bars under medial projection; mandibular basal spot yellow; lower inner and outer eye margins yellow, small yellow spot on upper eye margin; vertex with submedial yellow stripe; pronotal anterior carina, medially located sublateral stripe, and lateral spot yellow; scutum with tiny yellow medial spot and lateral margin yellow; mesopleuron with dorsal and medial yellow spots; tegular anterior margin yellow; scutellum and metanotum with large medial and smaller dorsolateral yellow spots; propodeum with large submedial yellow bands; forecoxa with apical yellow spot; mid- and hindcoxae with dorsal yellow stripe; fore- and midfemora with ventral yellow stripe; hindfemur ventrally yellow, dorsobasally dark brown, apically orange; tibiae and tarsi orange; terga I–IV with yellow subapical bands; tergum II–VII dark brown; sternum I medial spot; sterna II–III brown, with submedial yellow band; sternum IV–VII brown. Wing veins brown, with orange stig-

ma; marginal cell brown-tinted; rest of wing membrane lightly brown-tinted.

Female: Body length 9 mm. Vertex with large ovoid pit (Fig. 4); genal region appearing impressed; pronotum (Fig. 7) with elongate "neck" region, disk subovoid, rounded laterally and narrowest anteriorly, elevated above neck by weakly projecting bilobate anterior margin, somewhat impressed sublaterally; propleura bulging laterally on either side of pronotal neck in dorsal view; propodeum with long dorsal surface in lateral view, posterior surface gently convex; tergum II with two transverse ridges and rugosopunctate between; tergum V posteromedially emarginate with small medial tooth; tergum VI highly reduced laterally, medially produced into a ventrally V-shaped bilobate structure; sternum V ventrally emarginate, projecting laterally into three acute teeth; sternum VI small with broadly V-shaped apical lip. Body dark brown, with yellow markings on head (Fig. 3), pronotum with two yellow spots on posterior margin; scutum with transverse yellow band; tergum I with transverse anterior yellow band.

Type material.—Holotype, male, ARGENTINA: Corrientes, Las Marias, near Gobernador. Virasoro, Sept. 1971, C. Porter (GAINESVILLE). The holotype is missing the ultimate tarsomere on one midleg. Paratype female on same pin as holotype male, therefore with same data (GAINESVILLE).

Etymology.—This species is named after the collector, Charles Porter.

Discussion.—*Upa porteri* closely resembles *bidentata* and *impressiceps*; all three have the same clypeal modifications, strongly curved paramere in lateral view, and relatively similar coloration. Additionally, *porteri* and *impressiceps* have an apically emarginate hypopygium, and long slender aedeagal column with reduced dorsal and ventral lobes. *U. porteri* males strongly resemble those of *impressiceps*. They can be distinguished by the dorsally flat epipygium (strongly concave in *impressiceps*), and in *impressiceps* the paramere strongly curves around the aedeagus, almost enclosing it in dorsal view (Fig. 18). However, females of these two species are very different. In female *porteri* the pronotal disk is constricted anteriorly (not truncate as in *impressiceps*), the head is constricted across the genae, tergum VI is produced into a medial V-shaped process (not unciform, as in *impressiceps*), and sternum V is armed with three acute teeth on either side of terminalia (simple in the other species).

Upa tridentata Kimsey, New Species
(Figs. 1, 5, 9, 10, 13)

Description.—Male (holotype): Body length 12 mm; forewing length 10 mm. Face (Fig. 5) with small punctures 1 PD apart; clypeus gently convex in lateral view, apical margin tridentate; flagellomere I length 2.3× breadth; flagellomere II 2.8× as long as broad; vertex unmodified; mesonotal punctures 2–3 PD apart; propodeum polished and sparsely punctate, 3–5 PD apart or more; tergum I nearly impunctate, punctures becoming denser and very shallow toward apex of gaster; hypopygium tapering apically, apex sharply bidentate (Fig. 9); epipygium apically rounded; genital capsule (Fig. 13): paramere slightly curved and tapering apically (Fig. 10); aedeagus with large dorsal lobe followed by deep notch before apical loop, ventral lobes slender, elongate and subcapitate apically. Color black, with yellow on clypeus, except dorsal and apical margins; antennal lobes yellow, along inner and outer eye margins yellow; yellow between ocelli; mandible yellow medially; yellow band across vertex and along gena; pronotum with lateral yellow spot and transverse yellow band on anterior carina and posterior margin; scutum lateral margin yellow; scutellum anterolaterally yellow; metanotum medially and anterior margin yellow; mesopleural dorsal and medial spots yellow; propodeum with large U-shaped sublateral yellow spot and one anterior to spiracle; coxae ventrally yel-

low, hindcoxa also with oblique dorsal yellow stripe; terga I–IV posterior band and lateral edge yellowish orange; sterna I–IV medially yellowish orange; segments V–VII black; femora dark brown shading to orange and yellow; tibiae and tarsi orange; tegula orange. Wing veins orange; membrane yellow.

Paratype males vary in body length 12–14 mm, forewing length 10–11 mm, and to some extent coloration. Coloration varies considerably in extent but not pattern, with the clypeus mostly yellow to nearly all black, scutum with small yellow spot in one, tergal bands III and IV lack banding. Two of these specimens appear discolored and somewhat bleached, probably due to how they were preserved.

Female unknown.

Type material.—Holotype, male, BRAZIL: Rio de Janeiro, Mury, Nova Friburgo, Dec. 1975, Gred & Guimarães (SÃO PAULO). The holotype is missing the ultimate tarsomere on one midleg. Paratypes, 1 male: same data as type, except Dec. 1976 (female on same pin is a species of *Dolichothynnus*); 1 male: São Paulo, Santo, San Vicente, Nov. 1956 (LOS ANGELES); 1 male: "Brasilia," Mus. Drews. (COPENHAGEN); 2 males: Bahia, Encruzilhada, Nov. 1972 and 1974, M. Alvarenga (PITTSBURGH, COLLEGE STATION); 1 male: Minas Gerais, Nov. 1972 (OTTAWA).

Etymology.—The name refers to the tridentate clypeal margin.

Discussion.—The structure of the male clypeus, hypopygium and genital capsule indicate a close relationship with *longispina,* and less so *nasuta,* as discussed under those species.

Acknowledgments

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A NEW SPECIES OF *PALATKA* HULST (LEPIDOPTERA: PYRALIDAE: PHYCITINAE)

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Abstract.—***Palatka powelli*, n. sp.,** is described from New Mexico. Adults were reared from larvae feeding on *Limonium limbatum* Small (Plumbaginaceae).

Key Words: Lepidoptera, *Palatka,* Plumbaginaceae, *Limonium,* New Mexico

The only previously described species of *Palatka, P. nymphaeella* Hulst, occurs from Connecticut to Texas. It is a maritime species, feeding as a larva on sea lavender (*Limonium carolinianum* (Walter) Britton) a plant that belongs to the family Plumbaginaceae (Corrette and Neunzig 1979). Recently, Jerry Powell, University of California at Berkeley, brought to our attention another *Palatka* collected in New Mexico. The larval host of the New Mexican species has been identified as *Limonium limbatum* Small, that grows in the western United States mainly on saline flats, frequently near salt lakes, rather than in coastal environments.

Palatka powelli Neunzig and Solis, New Species

(Figs. 1–7)

Type locality.—Bitter Lake National Wildlife Refuge, Chaves Co., New Mexico.

Diagnosis.—*Palatka powelli* has a brown, well-delineated, distal band on the forewing, and, in the male the maxillary palpi bear, for the most part, long, slender scales, giving the palpi an aigrettelike appearance.

Description.—Length of forewing 7.5–8.0 mm. Head with frons roughly scaled, mostly white, reddish brown and black laterally; vertex roughly scaled, white; male antenna serrate with mesial edge of segments 3–8 forming a basal sinus, each segment produced distally into short, black spine, and entire sinus covered by weakly developed scale tuft; female antenna simple; labial palpus (Fig. 2) oblique to upcurved, extending slightly above vertex; mostly white, 2nd segment broadly scaled, with some black, mostly on distal half, 3rd segment small, mostly black; male maxillary palpus with 1st segment thin and as long as, or longer than, segments 2 and 3, scales white, mostly long and thin (Fig. 3), female maxillary palpus simple, white. Dorsum and collar of thorax mostly white washed with ochre or pale reddish brown, with a few black scales. Forewing mostly white; subbasal area with black spot; antemedial line distinct, white, preceded by broad, pale brown (black in some specimens) patch; distal margin of antemedial line partially delineated by black; postmedial line distinct, white, margined proximally and dis-

Fig. 1. *Palatka powelli* n. sp., male adult.

tally with thin line of black scales, distal line usually more complete than proximal line and followed by well-developed, broad brown band; discal spots distinct, black, usually somewhat fused together and with associated large pale-brown patch; medial area of wing also with scattered pale-brown and black scales; underside of wing of male without costal fold and sex-scaling. Hindwing dark, brownish gray, paler at fringe and in some specimens with a few pale streaks on veins. Male abdominal segment 8 with sclerotized, ventral plates (Fig. 7) and a pair of easily dislodged scale tufts. Male genitalia (Figs. 4, 5) with uncus broadly triangular; gnathos distally a simple hook; transtilla incomplete; juxta a broad flattened plate; valva elongate, narrow; sacculus produced into fingerlike element about one-sixth length of valva, extending toward costa; vinculum about as long as greatest width; aedoeagus with several stout cornuti. Female genitalia (Fig. 6) with ductus bursae shorter than corpus bursae, slightly sclerotized including triangular sclerite in basal half; corpus bursae without signum, with numerous microspines and with thickened distal appendage; ductus seminalis from corpus bursae near junction with ductus bursae.

Distribution.—Known only from southeastern New Mexico.

Holotype.—♂—Bitter Lake Wildlife Refuge, Chaves Co., New Mexico, V1-19-93, V. F. Hsu, J. Powell No. 93F43, emgd. V11-15-93, reared from *Limonium limbatum.* In the Essig Collection of the University of California, Berkeley.

Paratypes.—5 ♂♂, 3 ♀♀—same collection data as for holotype, except emergence dates V11-1, V11-7, V11-8, V11-13, V11-17, V11-22, and some with genitalia slides DA 108,109, HHN 3765 and JAP 6801. In the Essig Collection and National Museum of Natural History, Washington, D.C.

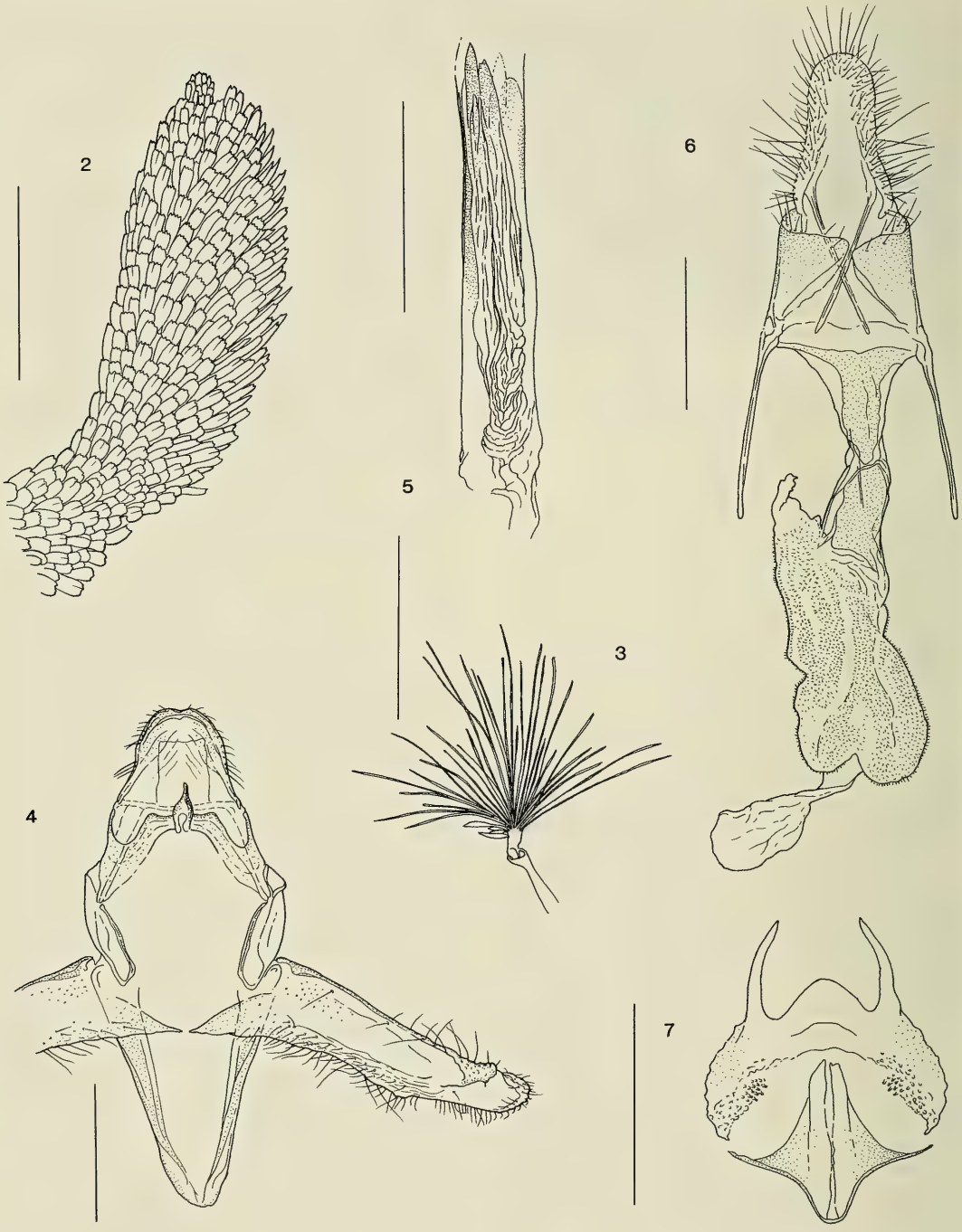
Discussion.—The genitalia of *P. powelli* and *P. nymphaeella* differ as follows: *P. powelli* has a short, fingerlike extension of the sacculus (about one-sixth length of valva), the ductus bursae is lightly sclerotized, and the thickened distal appendage of the corpus bursae is elongate, whereas *P. nymphaeella* has a longer fingerlike extension of the sacculus (about one-fourth length of valva), the ductus bursae is strongly sclerotized, and the thickened distal appendage of the corpus bursae is short.

The male eighth abdominal plates associated with the setal tufts also are diagnostic for the two species. The anterior plate of *P. powelli* is strongly convex anteriorly, and the posterior plate is somewhat reduced with slender hornlike lateral arms projecting posteriorly. *P. nymphaeella* has the anterior plate weakly convex anteriorly and the posterior plate more nearly complete. Heinrich (1956) for *P. nymphaeella* stated "Eighth abdominal segment of male simple." However, his figure 462b shows a sclerotized plate and setal tuft insertions on this segment.

Etymology.—*Palatka powelli* is named in honor of Jerry A. Powell.

Key to *Palatka* Adults

1. Forewing with well-delineated, transverse, broad, dark distal band (Fig. 1); maxillary palpus of male with many very slender scales (Fig. 3); southwestern United States . . . . . *powelli,* n. sp.
– Forewing without well-delineated, distal band; maxillary palpus of male with short scales; eastern United States . . . . . *nymphaeella* Hulst



Figs. 2–7. *Palatka powelli.* 2, Labial palpus. 3, Distal part of maxillary palpus. 4, Male genitalia (aedoeagus and juxta omitted). 5, Aedoeagus. 6, Female genitalia. 7, Ventral sclerites of 8th abdominal segment of male. All scale lengths 0.5 mm.

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CHECKLIST OF THE SCALE INSECTS (COCCOIDEA: HOMOPTERA) OF MEXICO

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Abstract.—The checklist includes 515 species-group names including 5 Aclerdidae, 11 Asterolecaniidae, 3 Cerococcidae, 63 Coccidae, 2 Conchaspididae, 4 Dactylopiidae, 224 Diaspididae, 15 Eriococcidae, 3 Halimococcidae, 4 Kermesidae, 5 Lecanodiaspididae, 20 Margarodidae, 16 Ortheziidae, 132 Pseudococcidae, and 8 Tachardiidae.

Key Words: Scale insect, Coccoidea, scale, mealybug, armored scale, soft scale, systematics, taxonomy, Mexico

Information on the scale insects of Mexico is scattered throughout the literature and often is found in publications that are not obvious sources of data on the Mexican Coccoidea. The purpose of this publication is to compile a checklist of the species known to occur in Mexico from all literature sources so that this information can be used for two additional projects. (1) An assessment of Mexican biodiversity that is being edited by four Mexican scientists entitled "Biodiversity, taxonomy and biogeography of Mexican arthropods: towards a synthesis"; (2) A database that is being developed by the Systematic Entomology Laboratory and the Entomological Collections Network called the "Biosystematic Information on Terrestrial Arthropods" which initally will develop a checklist of the arthropods of North America. State records within Mexico have been compiled either from the literature or from specimens deposited in the United States National Museum of Natural History, Beltsville, Maryland. In many instances species are known only from specimens taken at US ports-of-entry, and specific locality information is unknown.

Two species that I would expect to be common in Mexico each could be documented by only a single specimen taken at a United States port-of-entry with no specific locality information. These species have not been included in the list, because of insufficient data. They are *Pseudaulacaspis cockerelli* (Cooley) and *P. pentagona* (Targioni Tozzetti).

This checklist provides the valid name for each taxon known to occur in Mexico, a primary reference for each record, state records within Mexico, and an abbreviated synopsis of world distribution. Species epithets are given in alphabetical order within the genus followed by the author, a number that refers to a bibliographic reference, and locality information. United States Postal Service abbreviations are used for records from states in the U.S.

RESULTS

The list includes 15 families, 154 genera, and 515 species group names. Family representation is as follows: Aclerdidae 1 genus, 5 species; Asterolecaniidae 2 genera, 11 species; Cerococcidae 1 genus, 3 species; Coccidae 25 genera, 63 species; Con-

chaspididae 1 genus, 2 species; Dactylopiidae 1 genus, 4 species; Diaspididae 68 genera, 224 species; Eriococcidae 5 genera, 15 species; Halimococcidae 1 genus, 3 species; Kermesidae 3 genera, 4 species; Lecanodiaspididae 1 genus, 5 species; Margarodidae 8 genera, 20 species or subspecies; Ortheziidae 3 genera, 16 species; Pseudococcidae 31 genera, 132 species; Tachardiidae 2 genera, 8 species.

Aclerdidae

Aclerda
- *attenuata* Ferris 18 Mexico (Baja California), United States (TX)
- *manni* McConnell 18 Mexico (Baja California)
- *mexicana* McConnell 18 Mexico (Nuevo Leon)
- *oaxacaensis* McConnell 18 Mexico (Oaxaca)
- *sinaloaensis* McConnell 18 Mexico (Sinaloa)

Asterolecaniidae

Asterolecanium
- *cristatum* Ferris 31 Mexico (Baja California)
- *epidendri* Russell 31 Mexico (Chiapas, San Luis Potosí, Veracruz), most tropical areas
- *grandiculum* Russell 31 Mexico (no specific locality), United States (AZ, NM)
- *inlabefactum* Russell 31 Mexico (Veracruz)
- *pustulans* (Cockerell) 31 Mexico (Baja California, Chihuahua, Colima, Sinaloa, Tamaulipas, Veracruz) most tropical and subtropical areas of Mexico and the United States
- *townsendi* Cockerell 31 Mexico (Jalisco)
- *truncatum* Russell 31 Mexico (Chiapas, Jalisco), Guatemala, Honduras
- *urichi* Cockerell 31 Mexico (no specific locality), Brazil, Grenada, Nicaragua, Panama, Trinidad

Sclerosococcus
- *bromeliae* McKenzie 15 Mexico (no specific locality), United States (FL), Peru
- *ferrisi* McKenzie 15 Mexico (no specific locality)

Mycetococcus
- *corticis* (Townsend and Cockerell) 8a Mexico (Sonora, Veracruz)

Cerococcidae

Cerococcus
- *koebelei* (Cockerell) 16 Mexico (Distrito Federal, Mexico)
- *russellae* Kosztarab and Vest 16 Mexico (Morelos), Guatemala
- *zapotlanus* (Cockerell) 16 Mexico (Jalisco)

Coccidae

Akermes
- *colimae* Cockerell 3 Mexico (Colima)
- *townsendi* (Cockerell) 3 Mexico (Tabasco)

Cardiococcus
- *umbonatus* Cockerell 3 Mexico (Jalisco)

Ceroplastes
- *albolineatus* volcanicus Cockerell 3 Mexico (Jalisco)
- *angulatus* Cockerell 3 Mexico (Tabasco)
- *brachyurus* Cockerell 3 Mexico (Jalisco), United States (AL, AZ)
- *cirripediformis* Comstock 3 Mexico (Coahuila, Guanajuato, Veracruz), nearly cosmpolitan elsewhere
- *cistudiformis* Cockerell 3 Mexico (Distrito Federal, Guanajuato, Jalisco, Veracruz), United States (CA), Cuba
- *coloratus* Cockerell 3 Mexico (Tabasco)
- *dugesii* Lichtenstein 3 Mexico (Distrito Federal, Guanajuato, Jalisco, Tabasco), United States (FL), throughout Neotropics
- *floridensis* Comstock 3 Mexico (no specific locality), nearly cosmopolitan
- *irregularis* Cockerell 3 Mexico (Chihuahua), United States (AZ, CA, ID, NV, NM, TX)
- *macgregori* Sampedro and Butze 3 Mexico (Morelos)
- *marmoreus* Cockerell 3 Mexico (Jalisco)

minutus Cockerell 3 Mexico (Tabasco)
purpurellus Cockerell 3 Mexico (Jalisco)
sinensis Del Guercio 3 Mexico (Veracruz), nearly cosmopolitan

Ceroplastodes
dugesii (Signoret) 3 Mexico (Chihuahua), United States (NM, KS)

Coccus
hesperidum Linnaeus 3, 10 Mexico (probably occurs in all states of Mexico), cosmopolitan
longulus (Douglas) 3, 10 Mexico (Chihuahua, Distrito Federal, Guerrero, Nuevo Leon, San Luis Potosí, Veracruz) nearly cosmopolitan
pseudomagnoliarum (Kuwana) 3 Mexico (no specific locality), Holarctic
viridis (Green) new record Mexico (Chiapas, Colima) most tropical and subtropical areas

Ctenochiton
aztecus Townsend and Cockerell 3 Mexico (Tabasco)

Eulecanium
subaustrale Cockerell 3 Mexico (Puebla?)

Inglisia
malvacearum Cockerell 3 Mexico (Morelos), United States (TX)

Kilifia
acuminata (Signoret) 3 Mexico (Chihuahua, Distrito Federal, Guerrero, Nuevo Leon, Veracruz), most tropical areas of the world, also greenhouses.
americana Ben-Dov 3 Mexico (Guanajuato, Nuevo Leon, San Luis Potosí, Veracruz), United States (TX)

Megasaissetia
inflata (Cockerell and Parrott) 3 Mexico (Veracruz)

Mesolecanium
impar (Cockerell) 3 Mexico (Tabasco), Guyana
nocturnum (Cockerell and Parrott) 3 Mexico (Veracruz)
perditum (Cockerell) 3 Mexico (Yucatan)

Metapulvinaria
lycii (Cockerell) 3 Mexico (Baja California), United States (AZ, CA, NM, TX)

Milviscutulus
mangiferae (Green) 3, 10 Mexico (Baja Califonia, Chiapas, Colima, Guerrero, Jalisco, Morelos, Sinaloa, Tamaulipas, Veracruz), tropical

Neolecanium
chilaspidis (Cockerell) 3 Mexico (Oaxaca)
herrerae Cockerell 3 Mexico (Puebla)
imbricatum (Cockerell) 3 Mexico (Tamaulipas)
manzanillense Cockerell 3 Mexico (Colima)
plebeium Cockerell 3 Mexico (Colima)
sallei (Signoret) 3 Mexico (no specific locality)
tuberculatum (Townsend and Cockerell) 3 Mexico (Tabasco)

Parasaissetia
nigra (Nietner) 3 Mexico (Baja California, Chihuahua, Colima, Guanajuato, Guerrero, Jalisco, Michoacán, Morelos, Nayarit, Nuevo Leon, Oaxaca, Puebla, Queretaro, Sinaloa, Sonora), nearly cosmopolitan

Pendularia
jaliscensis (Cockerell and Cockerell) 3 Mexico (Jalisco)

Philephedra
colimensis (Cockerell) 3 Mexico (Colima)
crescentiae (Cockerell) 3 Mexico (Tabasco)
lutea (Cockerell) 3 Mexico (Colima, Distrito Federal, Guerrero, Nuevo Leon, Veracruz), United States (TX), Guatemala
mimosae (Townsend and Cockerell) 3 Mexico (Tabasco)
parvula (Cockerell) 3 Mexico (Colima, Jalisco, Morelos), United States (AZ)
tuberculosa Nakahara 3 Mexico (no specific locality), United States (FL, TX), Colombia, Costa Rica, Guatemala, Nicaragua, Venezuela

Platysaissetia
castilloae (Cockerell) 3 Mexico (Tabasco)
Pseudokermes
armatus Cockerell 3 Mexico (Tabasco)
Protopulvinaria
pyriformis (Cockerell) 3, 10 Mexico (Chiapas), most tropical or subtropical areas
Pulvinaria
elongata Newstead 3 Mexico (Sinaloa), United States (FL, GA, LA); Australia, Africa, Neotropics, Morocco, Spain
peninsularis Ferris 3 Mexico (Baja California), United States (TX)
Saissetia
miranda (Cockerell and Parrott) 3 Mexico (Chihuahua, Coahuila, Durango, Guerrero, Jalisco, Mexico, Michoacán, Morelos, Nayarit, Puebla, San Luis Potosí, Sinaloa, Sonora, Zacatecas), nearly cosmopolitan
neglecta DeLotto 3 Mexico (Colima, Guerrero, Jalisco, Nayarit, Sinaloa, Sonora), United States (FL, HA, LA), Bermuda, Central America, Puerto Rico, Venezuela
oleae (Olivier) 3 Mexico (San Luis Potosí), nearly cosmopolitan
tolucana (Parrott and Cockerell) 3 Mexico (Mexico)
Schizochlamidia
mexicana Cockerell and Parrott 3 Mexico (Veracruz)
Tillanococcus
mexicana Ben-Dov 3 Mexico (no specific locality), Guatemala
tillandsiae Ben-Dov 3 Mexico (Morelos, Veracruz), Guatemala, Honduras
Toumeyella
cerifera Ferris 3 Mexico (Baja California), United States (AL, AR, FL, LA, NC, VA)
mirabilis (Cockerell) 3 Mexico (Baja California), United States (AZ)
sonorensis (Cockerell and Parrott) 3 Mexico (Sonora)

Conchaspididae

Conchaspis
angraeci Cockerell 1 Mexico (Distrito Federal, Jalisco, San Luis Potasí, Tamaulipas, Veracruz), United States (CA, FL), Neotropics; Africa, Australia
newsteadi Cockerell 1 Mexico (Veracruz)

Dactylopiidae

Dactylopius
coccus Costa 29 Mexico (Oaxaca), Peru; Canary Islands
confusus (Cockerell) 29 Mexico (Durango, Guerrero, Jalisco, Morelos, Nuevo Leon, Puebla, Sonora), United States (AZ, CA, CO, FL, ID, MN, NE, NM, NV, NY, OK, SC, SD, UT, WA), Bahamas, Canada, Haiti, Peru; Algeria, Australia, Mauritius, South Africa
opuntiae (Cockerell) 29 Mexico (Baja California, Distrito Federal, Durango, Hidalgo, Mexico, Michoacán, Morelos, Oaxaca, Tamaulipas), United States (AZ, CA, HA, TX), Brazil, Jamaica; Australia, France, India, Kenya, Madagascar, Mauritius, Pakistan, Reunion Islands, South Africa, Sri Lanka
tomentosus (Lamark) 29 Mexico (Baja California, Chihuahua, Oaxaca), United States (AZ, CA, NM, NV, TX, UT), Argentina; Australia, South Africa

Diaspididae

Abgrallaspis
cyanophylli (Signoret) 4, 27 Mexico (Chihuahua, Colima, Nuevo Leon, Queretaro, San Luis Potosí, Sonora, Tabasco, Veracruz), widespread in tropics and subtropics
flabellata (Ferris) 4 Mexico (Guerrero)
fraxini McKenzie 27 Mexico (no specific locality), United States (AZ, CA)
howardi (Cockerell) 27 Mexico (no specific locality), most of United States

townsendi (Cockerell) 27 Mexico (Coahuila), most of United States

Acutaspis

agavis (Townsend and Cockerell) 27 Mexico (Durango, Jalisco, Mexico, Nayarit, Nuevo Leon, Queretaro, San Luis Potosí, Veracruz, Zacatecas), United States (AZ, TX), Costa Rica, Trinidad, Venezuela

albopicta (Cockerell) 4, 27 Mexico (Chiapas, Coahuila, Colima, Distrito Federal, Durango, Guerrero, Hidalgo, Jalisco, Morelos, Nuevo Leon, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz), United States (TX), Central America

aliena (Newstead) 4, 6, 27 Mexico (Chiapas, Jalisco, San Luis Potosí, Tamaulipas, Veracruz), United States (HA), Neotropics; United Kingdom

decorosa Ferris 4 Mexico (Baja California, Colima, Jalisco, Michoacán, Nayarit, Oaxaca, Sinaloa)

perseae (Comstock) 4, 27 Mexico (Nuevo Leon, San Luis Potosí, Veracruz, Yucatan) southeastern United States, Neotropics; Europe

reniformis (Cockerell) 4 Mexico (Oaxaca, Sonora)

rhizophorae (Cockerell) 4, 6 Mexico (Tabasco)

scutiformis (Cockerell) 4, 27 Mexico (Distrito Federal, Guerrero, Sinaloa), United States (TX), Argentina, Aruba, Brazil, Colombia, Guatemala

tingi McKenzie 4 Mexico (no specific location), Colombia

Ancepaspis

novemdentata Ferris 4 Mexico (Baja California)

quadridentata Ferris 4 Mexico (Guerrero)

tridentata (Ferris) 4, 27 Mexico (Baja California), United States (AZ, TX)

Annulaspis

singularis McKenzie 4 Mexico (Baja California)

Aonidiella

aurantii (Maskell) 4, 27 Mexico (Distrito Federal, Jalisco, Nuevo Leon, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz, Zacatecas), in nearly all citrus growing areas

citrina (Coquillett) 27 Mexico (Nuevo Leon), in nearly all citrus growing areas

orientalis (Newstead) 27 Mexico (Guerrero, Veracruz), United States (FL), Africa, Asia, Australia, Bahamas, Brazil, Caribbean Islands, Colombia, Panama, Venezuela; Pacific Islands

Aonidomytilus

albus (Cockerell) 4, 27 Mexico (no specific locality) United States (FL), warm areas of Neotropics; Africa, Asia

concolor (Cockerell) 4, 27 Mexico (Puebla, Veracruz), United States (AZ, CA, CO, NM, TX)

insulanus Ferris 4 Mexico (Baja California, Nayarit)

peninsularis (Ferris) 4, 27 Mexico (Baja California), United States (TX)

Aspidiella

sacchari (Cockerell) 27 Mexico (no specific locality), in nearly all areas where sugarcane is grown

Aspidiotus

destructor (Signoret) 4, 27 Mexico (Baja California, Chiapas, Guerrero, Jalisco, San Luis Potosí, Sinaloa, Veracruz), nearly cosmopolitan

excisus Green 27 Mexico (no specific locality), United States (FL), Neotropics; Asia, Pacific Islands

nerii Bouché 4, 27 Mexico (Baja Califonia, Chiapas, Chihuahua, Colima, Distrito Federal, Guanajuato, Jalisco, Mexico, Michoacán, Oaxaca, Puebla, San Luis Potosí, Sinaloa, Veracruz), nearly cosmopolitan

spinosus Comstock 4, 27 Mexico (Colima, San Luis Potosí), nearly cosmopolitan

tridentifer Ferris 27 Mexico (Oaxaca, Veracruz)

Carulaspis

minima (Targioni Tozzetti) 4 Mexico (no

specific locality), most temperate areas of the world

Chionaspis

etrusca Leonardi 27 Mexico (Chihuahua), United States (AZ, CA, TX); Europe, Africa, Turkey

gilli Liu and Kosztarab 17 Mexico (no specific locality), United States (AZ, CA, NM)

heterophyllae (Cooley) 4, 27 Mexico (no specific locality), United States, Bahamas

longiloba Cooley 27 Mexico (no specific locality), United States

pinifoliae (Fitch) 4, 27 Mexico (Baja California, Distrito Federal, Durango, Mexico, Michoacán, Nuevo Leon, Sinaloa, Zacatecas), United States, Canada, Cuba, El Salvador, Honduras; United Kingdom

platani Cooley 17 Mexico (Nuevo Leon), eastern United States

salicisnigrae (Walsh) 17 Mexico (no specific locality), United States

Chortinaspis

subchortina (Laing) 4, 27 Mexico (Veracruz), United States (AZ, FL, HA, MS, TX), Bahamas, Colombia, Jamaica, Panama, Peru

Chrysomphalus

aonidum (Linnaeus) Mexico (Baja California, Colima, Distrito Federal, Guerrero, Jalisco, Michoacán, Morelos, Nuevo Leon, Oaxaca, Sinaloa, Sonora, Tamaulipas), most tropical and subtropical areas

bifasciculatus Ferris 27 Mexico (no specific locality), southern United States; Asia, Former Soviet Union

dictyospermi (Morgan) 4 Mexico (Chiapas, Chihuahua, Colima, Distrito Federal, Durango, Jalisco, Nayarit, Nuevo Leon, Sinaloa, Sonora, Veracruz), greenhouses and tropical and subtropical areas

Circulaspis

bibursella Ferris 2, 4 Mexico (Colima)

fistulata (Ferris) 2, 4, 27 Mexico (Baja California)

Clavaspis

coursetiae (Marlatt) 4, 27 Mexico (Chihuahua, Queretaro, Sonora), United States (AZ, FL, TX), Panama

covilleae (Ferris) 4, 27 Mexico (Sinaloa, Sonora, Yucatan), United States (CA, AZ, NM)

herculeana (Cockerell and Hadden) 4, 27 Mexico (Chiapas, Tamaulipas), United States (FL, TX, HA), Neotropics; Africa, Asia, Australia, Pacific Islands

pedilanthi (Ferris) 4 Mexico (Baja California), United States (TX)

subsimilis (Cockerell) 4, 27 Mexico (Morelos), United States (TX), Guatemala

texana Ferris 4 Mexico (no specific locality), United States (TX)

Comstockiella

sabalis (Comstock) 4, 27 Mexico (Chihuahua, Sinaloa, Veracruz), southern United States, Caribbean; greenhouses in Europe

Crassaspis

maculata Ferris 4 Mexico (Sinaloa)

multipora (Ferris) 4, 27 Mexico (Baja California, Sonora), United States (AZ, CA)

Crenulaspidiotus

maurellae (Laing) 20 Mexico (Chiapas, Guerrero, Michoacán, San Luis Potosí, Yucatan), Central and South America

Dactylaspis

acuta (Ferris) 4 Mexico (Baja California)

calcarata (Ferris) 4 Mexico (Baja California)

dactylifera Ferris 4 Mexico (Colima)

flaccida Ferris 4 Mexico (Morelos)

serratiloba Ferris 4 Mexico (Guerrero), Panama

Diaspidiotus

aesculi (Johnson) 27 Mexico (no specific locality), western United States, Canada

ancylus (Putnam) 27 Mexico (Distrito Federal, Oaxaca), United States,

Brazil, Chile, Canada; Australia, South Africa

bumeliae Ferris 27 Mexico (no specific locality), United States (KS, OK, TX)

coniferarum (Cockerell) 4, 27 Mexico (Baja California), United States

crescentiae Ferris 4 Mexico (Sinaloa), Panama

osborni (Newell and Cockerell) 4, 27 Mexico (no specific locality), United States, Canada; South Africa

Diaspis

boisduvalii Signoret 4 Mexico (Chiapas, Distrito Federal, Queretaro, San Luis Potosí, Tamaulipas, Veracruz, Yucatan), nearly cosmopolitan

bromeliae (Kerner) 4, 27 Mexico (no specific locality), nearly cosmopolitan

coccois Lichtenstein new record Mexico (Chiapas), United States (CA), Jamaica; Algeria, France

concarpi McKenzie 4 Mexico (Oaxaca)

echinocacti Bouché 27 Mexico (Baja California, Chiapas, Durango, Nayarit, Puebla, Queretaro, San Luis Potosí, Sonora, Tamaulipas, Veracruz, Yucatan), common where ever cactus are grown

ferrisi McKenzie 4 Mexico (Oaxaca)

fraxini Ferris 4 Mexico (Sonora)

gilloglyi McKenzie 4, 27 Mexico (Chihuahua, San Luis Potosí, Veracruz), United States (CA), Belize, Guatemala, Jamaica

manzanitae (Whitney) 4, 27 Mexico (no specific locality), United States (CA)

miranda (Cockerell) 4 Mexico (Morelos, Veracruz)

parasiti McKenzie 4, 27 Mexico (Baja California), United States (CA)

radicicola Ferris 27 Mexico (Nuevo Leon), United States (TX); Algeria

simmondsiae Ferris 4, 27 Mexico (Baja California, Sonora), United States (AZ)

texensis (Cockerell) 4, 27 Mexico (Coahuila, Jalisco, Nuevo Leon, Oaxaca), United States (TX)

toumeyi Cockerell 27 Mexico (no specific locality), United States (AZ, TX)

townsendi Cockerell 4 Mexico (Baja California, Guanajuato, Jalisco, Nayarit)

Duplaspidiotus

fossor (Newstead) 4 Mexico (no specific locality), Barbados, Brazil

tesseratus (Grandpre and Charmoy) 4, 27 Mexico (Distrito Federal, Veracruz), nearly pantropical

Epidiaspis

baccharidis (Townsend and Cockerell) 4 Mexico (Mexico)

leperii (Signoret) 27 Mexico (no specific locality), United States (CA, CT, MD, NY, RI), Argentina, Chile, Uruguay; Africa, Asia, southern Europe

michoacana Ferris 4 Mexico (Michoacán, Morelos) Panama

montana (Cockerell) 27 Mexico (Michoacán), United States (AZ, NM)

peragrata Ferris 4 Mexico (Colima, Sinaloa), Panama

persimilis (Cockerell) 4 Mexico (Campeche, Morelos)

Exuviaspis

enceliae Ferris 4, 27 Mexico (Baja California), United States (CA)

Ferrisidea

dentiloba (Cockerell) 4 Mexico (Morelos, Puebla, Oaxaca)

magna (Ferris) 27 Mexico (Baja California), United States (CA, TX)

prosopidis (Ferris) 4 Mexico (Baja California)

Fiorinia

fioriniae (Targioni Tozzetti) 4, 27 Mexico (Chihuahua, Nuevo Leon, Veracruz), widespread in greenhouses and warm areas

theae Green 27 Mexico (Tamaulipas), eastern United States, Neotropics; Africa, Asia, Australia, Europe, Pacific Islands

Furcaspis

biformis (Cockerell) 27 Mexico (Coli-

ma), United States (FL, HA), Neotropics; Asia, Australia

Haliaspis

distichlii (Ferris) 4 Mexico (Baja California)

milleri Howell 12 Mexico (Puebla)

Helaspis

mexicana McKenzie 4 Mexico (Sinaloa)

Hemiberlesia

candidula (Cockerell) 4, 27 Mexico (no specific locality), United States (CA, AZ)

cupressi (Cockerell) 4 Mexico (Mexico)

diffinis (Newstead) 4, 27 Mexico (Chiapas, Coahuila, Jalisco, Morelos, Sinaloa, Tabasco, Tamaulipas), United States, Neotropics

lataniae (Signoret) 4 Mexico (Baja California, Chihuahua, Chiapas, Coachulia, Distrito Federal, Durango, Guanajuato, Jalisco, Mexico, Michoacán, Nuevo Leon, Oaxaca, Puebla, Queretaro, San Luis Potosí, Sinaloa, Tabasco, Tamaulipas, Veracruz, Zacatecas), greenhouses and tropical and subtropical areas

palmae (Cockerell) 4, 27 FL, Mexico (Veracruz), tropical and subtropical areas

popularum (Marlatt) 27 Mexico (Durango, San Luis Potosí, Sinaloa), western United States, Canada

rapax (Comstock) 4, 27 Mexico (Chihuahua, Guanajuato, Jalisco, Mexico, Michoacán, Puebla, Sinaloa, Sonora, Zacatecas), nearly cosmopolitan

Howardia

biclavis (Comstock) 4, 27 Mexico (Jalisco, Tobasco, Veracruz), most tropical and subtropical areas

Ischnaspis

longirostris (Signoret) 27 Mexico (Chiapas, Distrito Federal, Oaxaca, Sinaloa, Veracruz), most tropical and subtropical areas, greenhouses elsewhere

Lapazia

obtecta (Ferris) 4 Mexico (Baja California)

Lepidosaphes

beckii (Newman) 27 Mexico (Colima, Distrito Federal, Sinaloa), most citrus growing areas

camelliae Hoke 27 Mexico (no specific locality), United States; Asia

gloverii (Packard) 4 Mexico (Colima, Guerrero, Nayarit, Nuevo Leon, Sinaloa, Tamaulipas, Veracruz), most citrus growing areas

tokionis (Kuwana) 4, 27 Mexico (Colima, Guerrero, Nayarit, Sonora), Neotropics; Africa, Asia, Australia, Pacific Islands

ulmi (Linnaeus) 27 Mexico (no specific locality), most temperate areas

Lindingaspis

rossi (Maskell) 27 Mexico (Baja California), United States (CA, HA), Argentina, Brazil, Chile, Peru; Africa, Asia, Australia, southern Europe, New Caledonia, New Zealand

Lopholeucaspis

cockerelli (Grandpré and Charmoy) 27 Mexico (no specific locality) FL, HA, Neotropics; Africa, Asia, Australia, Europe, Pacific Islands

Manacaspis

piriformis Ferris 4 Mexico (Colima)

Melanaspis

bromiliae (Leonardi) 6, 27 Mexico (Oaxaca, Sonora, Veracruz), most tropical and subtropical areas, cosmopolitan

calura (Cockerell) 4, 6 Mexico (Distrito Federal, Veracruz), Costa Rica, Cuba, Guatemala, Haiti, Honduras, El Salvador; Philippines

coccolobae Ferris 6 Mexico (Chiapas, Colima, Guerrero, Morelos, Nayarit, Oaxaca, Sinaloa, Veracruz, Yucatan), United States (FL), Caribbean Islands, Central America, Venezuela

deliquescens Ferris 6 Mexico (Durango), United States (TX)

eglandulosa (Lindinger) 6 Mexico (no specific locality), United States (DC), Jamaica, Guatemala

elaeagni McKenzie 6 Mexico (Chiapas),

United States (LA, TX), Costa Rica, Guatemala, Honduras

enceliae (Ferris) 4, 6 Mexico (Baja California)

frankiniae Ferris 4, 6 Mexico (Baja California)

indurata (Ferris) 6 Mexico (Baja California)

latipyga Ferris 4, 6, 27 Mexico (Oaxaca), United States (TX), Guatemala, Panama

leivasi (Costa Lima) 4, 6 Mexico (Guerrero, Michoacán), Brazil, Guatemala, Panama

lilacina (Cockerell) 4, 6 Mexico (Baja California), United States (AZ, CA, NM)

mimosae (Comstock) 4, 6, 27 Mexico (Tamaulipas), United States (AZ, CA, FL)

nigropunctata (Cockerell) 4, 6, 27 Mexico (Distrito Federal, Guerrero, Hidalgo, Jalisco, Mexico, Michoacán, Morelos, Puebla) United States (FL, SC, TX, VA), Costa Rica, Guatemala, Panama, Puerto Rico

odontoglossi (Cockerell) 4, 6, 27 Mexico (Oaxaca), United States (FL), Ecuador, Honduras, Jamaica, Panama, Puerto Rico, Trinidad

pinicola Deitz and Davidson 6 Mexico (Chiapas), Guatemala

ponderosa Ferris 6 Mexico (Distrito Federal), Colombia, Panama

reticulata Ferris 4, 6 Mexico (Mexico)

rotunda Ferris 4, 6 Mexico (Michoacán)

sacculata Ferris 4, 6 Mexico (Guerrero)

smilacis (Comstock) 4, 6, 27 Mexico (Baja California, Chihuahua, San Luis Potosí) United States

squamea Ferris 6 Mexico (Oaxaca), Guatemala, Panama

sulcata Ferris 4, 6 Mexico (Colima, Guerrero, Jalisco, Nayarit, Oaxaca, Veracruz), Cuba, Jamaica, Panama; Germany, Japan, Philippines

tenax McKenzie 6 Mexico (Chiapas, San Luis Potosí, Veracruz, United States (FL), Neotropics

tenebricosa (Comstock) 4, 6, 27 Mexico (Tabasco), United States, Panama

tricuspis Ferris 4, 6 Mexico (Colima)

Morganella

cueroensis (Cockerell) 4, 27 Mexico (Michoacán), southeastern United States

longispina (Morgan) 4, 27 Mexico (no specific locality), United States (FL, HA), Neotropics; Africa, Asia, Australia, Pacific Islands

Mycetaspis

apicata (Newstead) 4, 27 Mexico (Chiapas, Veracruz) United States (TX), Brazil, Guyana, Panama

defectopalus Ferris 4, 27 Mexico (no specific locality), United States (FL, TX), Central and South America

personata (Comstock) 4, 27 Mexico (Chihuahua, Distrito Federal, Guerrero, Morelos, Nuevo Leon, Coahuila, San Luis Potosí, Sonora, Tabasco, Yucatan), United States (FL, HA), most tropical areas

sphaerioides (Cockerell) 4, 27 Mexico (Chihuahua, Coahuila, Colima, Distrito Federal, Nuevo Leon, San Luis Potosí), United States (LA), Guatemala, Panama

Mytilaspis

mexicana Cockerell 4 Mexico (Morelos)

Nicholiella

digitata Ferris 4 Mexico (Guerrero)

Niveaspis

argentata (Cockerell) 4 Mexico (no specific locality), Brazil, Panama

cattleyae Lepage 4 Mexico (Chiapas, Distrito Federal, Veracruz), Argentina, Brazil

fenestrata Ferris 4 Mexico (no specific locality), Panama

townsendiana (Cockerell) 4 Mexico (Colima, Sinaloa)

Nuculaspis

apacheca Ferris 27 Mexico (Chihuahua), United States (AZ), Guatemala

californica (Coleman) 4, 27 Mexico (Nuevo Leon), United States, Canada

Odonaspis
benardi Balachowsky 2 Mexico (Veracruz), United States (TX), Costa Rica, Cuba, Guatemala, Honduras, Martinique, Panama
graminis Bremner 2, 4, 27 Mexico (Mexico), United States (CA)
litorosa Ferris 2, 4, 27 Mexico (Baja California), United States (AZ, CO, TX), Panama
ruthae Kotinsky 2, 27 Mexico (Chihuahua, Sonora, Tamaulipas, Veracruz), United States (HA), southern United States, Neotropics; Africa, Australia, Israel, Pacific Islands, Pakistan, Sri Lanka

Opuntiaspis
carinata (Cockerell) 4, 27 Mexico (Coahuila, Guerrero, Jalisco, Morelos, Nuevo Leon, Oaxaca, San Luis Potosí, Tamaulipas, Veracruz), United States (FL, TX), Belize, Guatemala, Peru
javanensis Green 26 Mexico (Puebla); Java
philococcus (Cockerell) 4 Mexico (Coahuila, Distrito Federal, Oaxaca, Puebla, Querotaro, San Luis Potosí, Tamaulipas, Veracruz)

Parlatoria
camelliae Comstock 27 Mexico (no specific locality), United States, Argentina, Chile; Abkhazia, Asia, Europe
cinerea Hadden 4 Mexico (Baja California, Colima, Guerrero), most citrus growing areas, except United States
crotonis Douglas 27 Mexico (no specific locality), United States (FL, HA, LA), Neotropics; Africa, Asia, Pacific Islands, greenhouses elsewhere
oleae (Colveé) 27 Mexico (Chihuahua), most subtropical areas
pergandii Comstock 4 Mexico (Chihuahua, Coahuila, Distrito Federal, Oaxaca, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz), most tropical and subtropical areas
proteus (Curtis) 4, 27 Mexico (Colima, Guerrero, San Luis Potosí, Tamaulipas), most tropical and subtropical areas

Pinnaspis
aspidistrae (Signoret) 4 Mexico (Colima, Guerrero, Tamaulipas, Veracruz), most tropical and subtropical areas, greenhouses elsewhere
buxi (Bouché) 27 Mexico (Chihuahua, Veracruz), most tropical and subtropical areas
strachani (Cooley) 4 Mexico (Baja California, Campeche, Chihuahua, Colima, Coahuila, Distrito Federal, Durango, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz), most tropical and subtropical areas, greenhouses elsewhere

Protodiaspis
agrifoliae Essig 27 Mexico (no specific locality), United States (CA)
colimae Ferris 4 Mexico (Colima, Michoacán), Panama
infidelis Ferris 4 Mexico (Guerrero), Guatemala, Panama
lagunae Ferris 4 Mexico (Baja California)
parvula Cockerell 4 Mexico (Mexico)
praetexta Ferris 4 Mexico (Oaxaca)
pulchra Ferris 4, 27 Mexico (Oaxaca), United States (AZ)
sulcata Ferris 4 Mexico (Guerrero)
vara Hoke 4, 27 Mexico (Mexico), United States (AR, MS, TN, TX)

Pseudaonidia
trilobitiformis (Green) 27 Mexico (Chihuahua, Guerrero), United States (FL), most tropical and subtropical areas

Pseudischnaspis
acephala Ferris 21 Mexico (no specific locality), Colombia, Panama, Peru
bowreyi (Cockerell) 4, 21, 27 Mexico (Michoacán, Tabasco, Yucatan), United States (FL), Neotropics

Pseudodiaspis
elaphrii Ferris 4 Mexico (Baja California)

Pseudoparlatoria
browni McKenzie 4 Mexico
carolilehmanni Balachowsky new record Mexico (Nayarit), Colombia, Ecuador, Guatemala
elongata Ferris 4 Mexico (Distrito Federal ?)
fusca Ferris 4 Mexico (Veracruz), Colombia
maculata Ferris 4 Mexico (Guerrero)
ostreata Cockerell 4, 27 Mexico (no specific locality), United States (FL), Neotropics; Africa, Europe in greenhouse
parlatorioides (Comstock) 4 Mexico (Chiapas, Chihuahua, Distrito Federal, Durango, Jalisco, Oaxaca, Puebla, Sinaloa, Tamaulipas, Veracruz), United States (AL, FL, GA, HA, TX), Neotropics; New Zealand, Spain, Sri Lanka, greenhouses elsewhere
perparvula Ferris 4 Mexico (Colima, Guanajuato, Jalisco, Nayarit, Veracruz)
petasata Ferris 4 Mexico (Veracruz)
punctata Ferris 4 Mexico (Guerrero)
serrulata Townsend and Cockerell 4 Mexico (Morelos, Sonora)
Quadraspidiotus
forbesi (Johnson) 4, 27 Mexico (Chihuahua, Coahuila, Sonora) United States, Canada; South Africa
juglansregiae (Comstock) 27 Mexico (no specific locality), United States, Canada
perniciosus (Comstock) 4, 27 Mexico (Baja California, Chihuahua, Coahuila, Morelos, Nuevo Leon, Puebla, Sonora), most temperate areas
Quernaspis
quercus (Comstock) 27 Mexico (no specific locality), United States
Rhizaspidiotus
dearnessi (Cockerell) 4, 27 Mexico (San Luis Potosí, Veracruz), United States, Canada, Cuba
Rugaspidiotinus
circumdatus (Ferris) 4 Mexico (Baja California)
fuscitatis (Ferris) 4 Mexico (Baja California)
Rugaspidiotus
arizonicus (Cockerell) 4, 27 Mexico (Baja California), United States (AZ, CA)
sculpturatus Ferris 4, 27 Mexico (Baja California), United States (AZ)
Scytalaspis
quadriclavata Ferris 4 Mexico (Guerrero)
Selenaspidopsis
browni Nakahara 28 Mexico (Chiapas, Distrito Federal, Veracruz)
mexicana Nakahara 28 Mexico (Veracruz)
Selenaspidus
articulatus (Morgan) 4 Mexico (Chiapas, Distrito Federal, Puebla, Veracruz), United States (FL), Neotropics; Africa, Fiji, Guam, Philippines
Situlaspis
ruelliae (Ferris) 4 Mexico (Baja California)
yuccae (Cockerell) 4, 27 Mexico (Baja California, Chihuahua, Distrito Federal, Sonora), United States (AZ, CA, FL, NM, OK, TX)
Stramenaspis
kelloggi (Coleman) 27 Mexico (Jalisco, Puebla), United States (AZ, CA, NM, TX, WA)
Targionia
bigeloviae (Cockerell) 27 Mexico (Veracruz), United States (CA, TX)
yuccarum (Cockerell) 4, 27 Mexico (Baja California), United States (AZ, NM, TX)
Unaspis
citri (Comstock) 4 Mexico (Distrito Federal, Puebla, Veracruz), United States (FL, LA), most citrus areas
euonymi (Comstock) 4 Mexico (no specific locality), most areas where euonymous is grown
Velataspis
anasterias Ferris 27 Mexico (Baja Cali-

fornia), United States (TX), Nicaragua, Panama

mimosarum (Cockerell) 4, 27 Mexico (Jalisco, Oaxaca), United States (NM, TX), Guatemala

Vinculaspis

laniata (Ferris) 4 Mexico (Oaxaca)

virgata (Ferris) 4 Mexico (Colima), Panama

Xanthophthalma

concinnum Cockerell and Parrott 4 Mexico (Chiapas, Veracruz), Colombia, Cuba, Honduras, Panama

Xerophilaspis

prosopidis (Cockerell) 4, 27 Mexico (Sonora), United States (AZ, CA, TX)

Eriococcidae

Acanthococcus

araucariae (Maskell) 13 Mexico (Distrito Federal), wherever *Araucaria* is grown

aurescens Cockerell 13 Mexico (Platanas) **n. comb.**

coccineus (Cockerell) 13 Mexico (Chihuahua, Coahuila, Queretaro, San Luis Potosí, Tamaulipas, Veracruz, Zacatecas), wherever cactus is grown

dubius (Cockerell) 13, 21 Mexico (San Luis Potosí), warm areas of United States

gerbergi (McDaniel) 13, 22 Mexico (Distrito Federal), United States (AZ, ID, NV, UT)

larreae (Parrott and Cockerell) 13, 22 Mexico (Baja California), United States (CA, NV, NM, TX)

palmeri Cockerell 13, 22 Mexico (Baja California) **n. comb.**

paucispinus Ferris 13 Mexico (Baja California) **n. comb.**

quercus (Comstock) 13, 22 Mexico (no specific locality), United States

shiraiwai Kuwana 13 Mexico (no specific locality) **n. comb.**

tillandsiae Ferris 13 Mexico (Baja California) **n. comb.**

Capulinia

sallei Signoret 13 Mexico (Arroyo San Isidro), Cuba

Carpochloroides

mexicanus Ferris 13 Mexico (Oaxaca)

Oregmopyga

peninsularis (Ferris) 13 Mexico (Baja California)

Xerococcus

fouquieriae Ferris 13 Mexico (Baja California)

Halimococcidae

Colobopyga

attaleae (Stickney) 4 Mexico (Colima)

sabalis (Ferris) 4 Mexico (Oaxaca)

washingtoniae (Ferris) 4 Mexico (Baja California)

Kermesidae

Allokermes

galliformis (Riley) 17 Mexico (Oaxaca), United States

grandis (Cockerell) 17 Mexico (Mexico)

Kermes

nigropunctatus Ehrhorn and Cockerell 17 Mexico (Chihuahua), United States (CA)

Olliffiella

secunda Ferris 17 Mexico (Guerrero)

Lecanodiaspididae

Lecanodiaspis

dendrobii (Douglas) 11 Mexico (no specific locality), Argentina, Colombia, Guatemala, Guyana, Honduras, Venezuela

partheniae Howell and Kosztarab 11 Mexico (Coahuila, San Luis Potosí)

prosopidis (Maskell) 11 Mexico (Coahuila, Oaxaca, Sonora), United States

rufescens (Cockerell) 11 Mexico (no specific locality), United States (AZ, CA, CO, NM), Chile

tapirirae Ferris and Kelly 11 Mexico (Baja California)

Margarodidae

Cryptokermes
mexicanus Morrison 24 Mexico (Jalisco, Morelos)
Icerya
colimensis Cockerell 24 Mexico (Colima, Mexico)
littoralis Cockerell 24 Mexico (Guerrero, Tabasco)
littoralis mimosae Cockerell 24 Mexico (no specific locality)
littoralis tonilensis Cockerell 24 Mexico (Jalisco)
montserratensis Riley and Howard 24 Mexico (no specific locality), Caribbean, Central America, Colombia
palmeri Riley and Howard 24 Mexico (Baja California, Sonora)
purchasi Maskell 24 Mexico (Chihuahua, Morelos, Nuevo Leon, Puebla, Sonora, Tamaulipas), most tropical and subtropical areas
rileyi Cockerell new record Mexico (Chihuahua), southwestern United States
rileyi larreae Cockerell 24 Mexico (Chihuahua)
Llaveia
axin (Llave) 24 Mexico (Veracruz), Panama
mexicanorum Cockerell 24 Mexico (Mixcoac-a hill)
oaxacoensis Morrison 24 Mexico (Oaxaca)
Marchalina
azteca Ferris 24 Mexico (Distrito Federal)
Matsucoccus
leiophyllae Ray and Williams 30 Mexico (Distrito Federal), United States (AZ)
Neosteingelia
texana Morrison Mexico (Chiapas), eastern United States
Protortonia
primitiva (Townsend) 24 Mexico (Morelos)
Steatococcus
mexicanus (Cockerell) 24 Mexico (Baja California)
morrilli (Cockerell) Mexico (no specific locality), United States (AZ, CA, NM)
tabernicolus Ferris 24 Mexico (Chihuahua)

Ortheziidae

Newsteadia
tristani Silvestri 25 Mexico (Chiapas), Costa Rica
Nipponorthezia
obscura Morrison 25 Mexico (no specific locality), United States (FL, IL, PA, SC, VA), Guatemala
Orthezia
acapulcoa Morrison 25 Mexico (Guerrero)
cacticola Morrison 25 Mexico (Queretaro)
caudata Ferris 23 Mexico (Baja California)
ferrisi Morrison 25 Mexico (Baja California, Sonora)
insignis Browne 25 Mexico (Chihuahua, Guanajuato, Michoacán, Veracruz, Zacatecas), most tropical and subtropical areas
lasiorum Cockerell 25 Mexico (no specific locality), United States (NM)
mexicana Morrison 23 Mexico (no specific locality)
pini Morrison 25 Mexico (Guerrero)
pinicola Morrison 25 Mexico (Durango, Morelos)
praelonga Douglas 25 Mexico (Guerrero), Central America, Colombia, Venezuela
pseudinsignis Morrison 25 AZ, Mexico (Baja California, Jalisco, Sonora, Veracruz), Guatemala, Peru
selaginella Morrison 25 Mexico (Guanajuato)
smythi Morrison 25 Mexico (Distrito Federal)
sonorensis Cockerell 23 Mexico (Sonora)

Pseudococcidae

Amonostherium
lichtensioides (Cockerell) 19, 33 Mexico (Coahuila), United States (CA, CO, NM, NV, TX)

Anisococcus
milleri Williams and Granara de Willink 33 Mexico (Puebla, Tamaulipas)

Antonina
graminis (Maskell) 33 Mexico (Chihuahua, Michoacán, Nayarit, Nuevo Leon, Oaxaca, Puebla, Sinaloa, Tamaulipas, Veracruz), nearly cosmopolitan
nortoni Parrott and Cockerell 8, 33 Mexico (no specific locality), United States (AZ, KS, TX)

Antoninoides
parrotti (Cockerell) 8, 33 Mexico (Nuevo Leon), United States (KS, TX)

Cataenococcus
cualatensis (Cockerell) 33 Mexico (Colima)
ductorum Williams and Granara de Willink 33 Mexico (no specific locality)
guatemalensis Ferris 33 Mexico (Chiapas, Distrito Federal, Oaxaca, Puebla, San Luis Potosí, Veracruz), Central America, Brazil, Colombia, Dominican Republic, Jamaica
ingrandi Balachowsky 33 Mexico (no specific locality), Colombia, Costa Rica, Guatemala, Panama
larai Williams 33 Mexico (no specific locality), Colombia, Costa Rica
olivaceus (Cockerell) 19, 33 Mexico (Morelos), United States (CA, FL, TX)

Chorizococcus
rostellum (Lobdell) 19, 33 Mexico (Nayarit, Sonora), United States (CA, LA, MD, MS), Argentina, Brazil; Australia, Italy
triunfoensis Williams and Granara de Willink 33 Mexico (Baja California)

Distichlicoccus
sahuayoensis Williams and Granara de Willink 33 Mexico (Michoacán)
salinus (Cockerell) 19, 33 Mexico (Baja California), United States (CA)
sinaloanus Williams and Granara de Willink 33 Mexico (Sinaloa)
zacapuensis Williams and Granara de Willink 33 Mexico (Michoacán)

Dysmicoccus
bispinosus Beardsley 33 Mexico (Oaxaca), most of Central & South America, Caribbean Islands
boninsis (Kuwana) 33 Mexico (Tamaulipas), most areas where sugarcane is grown
brevipes (Cockerell) 33 Mexico (Chihuahua, Colima, Distrito Federal, Hidalgo, Jalisco, Nayarit, Oaxaca, Veracruz), warm areas of the world
grassi (Leonardi) 33 Mexico (Tamaulipas, Veracruz), United States (FL), Caribbean Islands, most of Central America, northern South America; Canary Islands
hurdi McKenzie 33 Mexico (Veracruz)
mackenziei Beardsley 19, 33 Mexico (Chiapas, Veracruz), United States (CA), Central America, Ecuador, Jamaica
neobrevipes Beardsley 33 Mexico (no specific locality), Caribbean Islands, most of Central & South America; Asia, Pacific Islands
pinicolus McKenzie 19, 33 Mexico (Tlaxcala), United States (CA, NV)
texensis (Tinsley) 8, 33 Mexico (Veracruz), United States (TX)

Ehrhornia
cupressi (Ehrhorn) 19, 33 Mexico (Baja California), United States (CA, OR)

Ferrisia
consobrina Williams and Watson 33 Mexico (Because of the numerous misidentifications of *F. consobrina* as *F. virgata* no specific locality information is given for this species or *F. virgata*) Argentina, Bahamas, Bermuda, Cuba, Jamaica, Peru, Trinidad
virgata (Cockerell) 33 Mexico (no spe-

cific locality), most warm areas of the world

Geococcus

coffeae Green 33 Mexico (no specific locality), most tropical areas

Heliococcus

corralesi Williams and Granara de Willink 33 Mexico (Coahuila)

deserticola Miller 33 Mexico (Michoacán), United States (CA, NV, TX)

Humococcus

atriplicis Ferris 19, 33 Mexico (no specific locality), United States (CA, TX)

hilariae (Ferris) 19, 33 Mexico (Chihuahua), United States (CA, NM, TX)

yenseni Williams and Granara de Willink 33 Mexico (Sonora)

Hypogeococcus

boharti Miller 33 Mexico (Oaxaca, Veracruz), Belize, El Salvador, Guatemala, Honduras, Panama

othnius Miller and McKenzie 33 Mexico (Chiapas, Oaxaca) Central America, Ecuador, Venezuela

spinosus Ferris 19, 33 Mexico (no specific locality), United States (CA, TX), Argentina, Brazil, Venezuela

Lachnodiella

mexicana Ferris 33 Mexico (Tamaulipas)

Nipaecoccus

cercidii Williams and Granara de Willink 33 Mexico (Baja California)

filamentosus (Cockerell) 7, 33 Mexico (Baja California), Haiti; Turks and Caicos Islands

filicis Williams and Granara de Willink 33 Mexico (Puebla)

gilli Williams and Granara de Willink 33 Mexico (Sinaloa, Veracruz)

jonmartini Williams and Granara de Willink 33 Mexico (Jalisco), Colombia, Costa Rica, Ecuador, El Salvador, Panama, Venezuela

kosztaraborum Williams and Granara de Willink 33 Mexico (Morelos), Costa Rica

neogaeus Williams and Granara de Willink 33 Mexico (no specific locality), Brazil, Colombia, Trinidad

nipae (Maskell) 33 Mexico (Chiapas, Jalisco, Puebla, Tabasco, Veracruz), most tropical areas of the world

zapotlanus (Cockerell) 33 Mexico (Jalisco)

Palmicultor

palmarum (Ehrhorn) 33 Mexico (no specific locality), Bahamas, Bermuda, Jamaica; Pacific Islands

Paracoccus

alazanensis Williams and Granara de Willink 33 Mexico (Veracruz)

baccharidicola Williams and Granara de Willink 33 Mexico (Hidalgo)

circuliprivis Ezzat and McConnell 33 Mexico (San Luis Potosí)

ferrisi Ezzat and McConnell 33 Mexico (Chihuahua, Jalisco, Nayarit, Nuevo Laredo, Sonora, Yucatan)

hamoni Williams and Granara de Willink 33 Mexico (no specific locality)

herreni Williams and Granara de Willink 33 Mexico (Chiapas), Colombia, Nicaragua

juniperi (Ehrhorn) 33 Mexico (Distrito Federal), western United States

lycopersici Ezzat and McConnell 33 Mexico (Colima, Guerrero, Jalisco, Nayarit, Puebla, Tabasco, Tamaulipas), Chile

marginatus Williams and Granara de Willink 33 Mexico (Baja California, Veracruz), Belize, Costa Rica, Guatemala

mexicanus Ezzat and McConnell 33 Mexico (Michoacán)

oneratus Williams and Granara de Willink 33 Mexico (no specific locality)

ordinis Williams and Granara de Willink 33 Mexico (Mexico)

reductus (Ferris) 33 Mexico (Baja California), United States (CA)

salviacola Williams and Granara de Willink 33 Mexico (Michoacán)

solani Ezzat and McConnell 33 Mexico (Sinaloa), Costa Rica, Peru

townsendi (Cockerell) 19, 33 Mexico

(Chihuahua, Coahuila, San Luis Potosí, Zacatecas), United States (NM, TX)

villanuevai (Miller and McKenzie) 33 Mexico (Veracruz)

Phenacoccus

capensis Ferris 33 Mexico (Baja California)

defectus Ferris 19, 33 Mexico (Coahuila), United States (CA)

eremicus Ferris 19, 33 Mexico (no specific locality), United States (CA), Argentina

eschscholtziae McKenzie 19, 33 Mexico (Querétaro), United States (CA)

franseriae Ferris 33 Mexico (Baja California, Morelos)

gossypii Townsend and Cockerell 33 Mexico (Tabasco), southern United States

gregosus Williams and Granara de Willink 33 Mexico (Chiapas, Colima), Costa Rica

helianthi (Cockerell) 33 Mexico (Michoacán), southern United States

hurdi McKenzie 33 Mexico (Baja California), southern United States

incomptus McKenzie 33 Mexico (no specific locality)

madeirensis Green 33 Mexico (no specific locality), Caribbean Islands, Central and South America; Africa, Pacific Islands

mexicanus (Miller and McKenzie) 33 Mexico (Tlaxcala)

parvus Morrison 33 Mexico (no specific locality), Caribbean Islands, Central and South America

psidiarum (Cockerell) 33 Mexico (Jalisco)

solani Ferris 33 Mexico (Chihuahua, Distrito Federal, Michoacán, Nuevo Leon, Sonora, Tamaulipas, Yucatan), most of United States, Brazil, Curacao, Guatemala, Trinidad, Venezuela; Kiribati, Micronesia, South Africa, Zimbabwe

solenopsis Tinsley 19, 33 Mexico (Baja California, Colima, Nuevo Leon, Quintana Roo, Sinaloa, Sonora), southern United States, Cuba, Dominican Republic, Ecuador, Panama

Planococcus

citri (Risso) 33 Mexico (probably occurs in every state in Mexico), cosmopolitan

minor (Maskell) 33 Mexico (no specific locality), most tropical areas except continental Africa, not in United States

Pororococcus

pergandei Cockerell 33 Mexico (Morelos)

tinctorius Cockerell 33 Mexico (Mexico)

Prorhizoecus

atopoporus Miller and McKenzie 33 Mexico (Puebla)

Pseudantonina

texana Ferris 33 Mexico (Mexico), United States (TX)

Pseudococcus

agavis MacGregor 33 Mexico (Michoacán, Mexico)

calceolariae (Maskell) 33 Mexico (no specific locality), United States (CA), Chile; Australia, England, South Africa

comstocki (Kuwana) 33 Mexico (Chihuahua), eastern US, CA, NM, Argentina, Canada; Europe, Far East

elisae Borchsenius 33 Mexico (Chiapas, Chihuahua), United States (HA), most tropical areas except Africa

longispinus (Targioni Tozzetti) 33 Mexico (probably occurs in every state in Mexico), cosmopolitan

microcirculus McKenzie 33 Mexico (Morelos, San Luis Potosí, Veracruz), United States in greenhouses, Neotropics; Belgium, United Kingdom

viburni (Signoret) new record Mexico (Baja California, Sinaloa, Queretaro), nearly cosmopolitan

Puto

ambiguus (Fullaway) 33 Mexico (Baja California), United States (CA)

californicus McKenzie 19, 33 Mexico

(Baja California), United States (CA)

lasiorum (Cockerell) 33 Mexico (Puebla, Tlaxcala), United States (NM)

mexicanus (Cockerell) 7, 33 Mexico (Baja California, Chihuahua, Distrito Federal, Durango, Guanajuato, Jalisco, Michoacán, Morelos, Nuevo Leon, Oaxaca, Sinaloa, Tamaulipas, Tlaxcala, Veracruz), United States (AZ)

orthezioides (Cockerell) 33 Mexico (Guanajuato)

simmondsiae McKenzie 19, 33 Mexico (Sonora), United States (CA)

ulter Ferris 33 Mexico (no specific locality), Guatemala, Venezuela

yuccae (Coquillett) 33 Mexico (no specific locality), southwestern United States

Radicoccus

kelloggi (Ehrhorn and Cockerell) 33 Mexico (Nuevo Leon, Tlaxcala), United States (CA, CT, NJ)

Rhizoecus

americanus (Hambleton) 9, 33 Mexico (Veracruz), United States (FL), Caribbean Islands, Central America, Colombia, Ecuador

apizacos Hambleton 9, 33 Mexico (Tlaxcala)

associatus (Hambleton) 9, 19, 33 Mexico (Mexico), United States (CA), Guatemala

cyperalis (Hambleton) 9, 33 Mexico (no specific location), El Salvador

disjunctus McKenzie 9, 33 Mexico (Puebla), United States (CA)

falcifer Kunckel d'Herculais 9, 33 Mexico (no specific locality), United States (CA, FL, MO, NJ, NY), Surinam, Trinidad; Europe

gracilis McKenzie 9, 33 Mexico (Mexico, Tlaxcala, Veracruz), western United States, VA

leucosomus (Cockerell) 9, 33 Mexico (Veracruz), United States

macgregori Hambleton 33 Mexico (Michoacán)

menkei McKenzie 33 Mexico (Nayarit)

mexicanus (Hambleton) 33 Mexico (no specific locality)

neomexicanus McKenzie 33 Mexico (Veracruz)

neostangei Miller and McKenzie 33 Mexico (Veracruz)

ovatus Hambleton 33 Mexico (no specific locality)

pauciporus Hambleton 33 Mexico (Chiapas)

polyporus Hambleton 33 Mexico (Sonora)

solani (Hambleton) 33 Mexico (Tamaulipas), Guatemala

spinipes (Hambleton) 9, 33 Mexico (Veracruz), United States (AK, FL, GA)

stangei McKenzie 33 Mexico (Nayarit)

tropicalis Hambleton 33 Mexico (Veracruz), Guatemala

Saccharicoccus

sacchari (Cockerell) 33 Mexico (Chihuahua, Sinaloa, Veracruz), nearly all areas where sugar cane is grown

Spilococcus

eriogoni (Ehrhorn) 19, 33 Mexico (Baja California), United States (CA, MD, TX)

larreae Ferris 19, 33 Mexico (Chihuahua), United States (AZ, CA)

mamillariae (Bouché) 33 Mexico (Veracruz), nearly all areas where cacti are grown

sequoiae (Coleman) 33 Mexico (Baja California), United States (CA)

steelii (Cockerell and Townsend) 7, 33 Mexico (Chihuahua), United States (NM, TX)

Syrmococcus

pecosensis Ferris 8, 33 Mexico (Durango, Nayarit), United States (TX)

Trionymus

coronus Miller and McKenzie 33 Mexico (Veracruz)

Tachardiidae

Austrotachardiella

nigra (Townsend and Cockerell) 14, 32 Mexico (Jalisco)

rotundata (Cockerell) 14, 32 Mexico (Jalisco)

Tachardiella

cornuta (Cockerell) 14, 32 Mexico (Chihuahua), United States (NM, TX)

ferrisi Chamberlin 14, 32 Mexico (Baja California)

fulgens (Cockerell) 14, 32 Mexico (Sonora), United States (AZ)

ingae (Hempel) 32 Mexico (no specific locality), United States (AZ, CA, NV), Brazil

larreae (Comstock) 14 Mexico (Sonora), southwestern United States

mexicana (Comstock) 14 Mexico (Oaxaca), United States (TX)

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PTEROMALUS ELEVATUS (WALKER) (HYMENOPTERA: PTEROMALIDAE): NORTH AMERICAN RECORDS OF AN IMMIGRANT PARASITOID OF THE GALL FLY *UROPHORA JACEANA* (DIPTERA: TEPHRITIDAE)

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Abstract.—*Pteromalus elevatus* (Walker), a Palearctic species, is reported from several localities in Nova Scotia as a probable parasitoid of the gall-inducing tephritid *Urophora jaceana* (Hering) on black knapweed (*Centaurea nigra*). These records are only the third for *P. elevatus* in the New World; the first such record (Newfoundland), published in the European literature, has been overlooked by North American workers, and a collection of specimens in New Brunswick has been briefly noted in the American literature. This species is described and its distribution and habits in the Old World are summarized.

Key Words: Insecta, Pteromalidae, parasitism, adventive insects, biological control, Tephritidae

As part of continuing surveys for immigrant insects in the Canadian Maritime Provinces, we report here the collection of *Pteromalus elevatus* (Walker) (Hymenoptera: Pteromalidae), a species widely distributed in the western part of the Palearctic region and a known parasitoid of the knapweed gall fly *Urophora jaceana* (Hering) (Diptera: Tephritidae). During the summers of 1993–1995, this pteromalid was taken at numerous sites in Nova Scotia by sweeping flowerheads of black knapweed (*Centaurea nigra* L.). This plant is a principal host of *U. jaceana,* also native to central and western Europe and accidentally introduced into eastern Canada (Foote et al. 1993).

Although a North American record (Newfoundland) for *P. elevatus* was published by Graham (1969) in his monograph of the Pteromalidae of Northwestern Europe, it was inadvertently omitted from the list of pteromalids in the Catalog of Hymenoptera in America North of Mexico (Burks 1979). In addition, Peschken et al. (1982) reported that 3% of 580 *U. cardui* (L.) larvae from galls on Canada thistle (*Cirsium arvense* (L.) Scop.) at Sussex Corner, New Brunswick, were parasitized by this pteromalid (as *Habrocytus elevatus*). The two literature records and our own collection records for *P. elevatus* in Nova Scotia are listed and mapped, together with a short description of the parasitoid and information on its geographic distribution, hosts, natural history, and possible mode of introduction.

Pteromalus elevatus (Walker)

Eutelus elevatus Walker 1834: 366.

Pteromalus elevatus: Walker 1848: 77, Bouček and Graham 1978a: 228, 1978b: 81.

Habrocytus elevatus: Kurdjumov 1913: 13, Bouček 1965: 8, Graham 1969: 538.

A complete synonymy for this species can be found in Graham (1969: 538–539), and Bouček and Graham (1978a: 81).

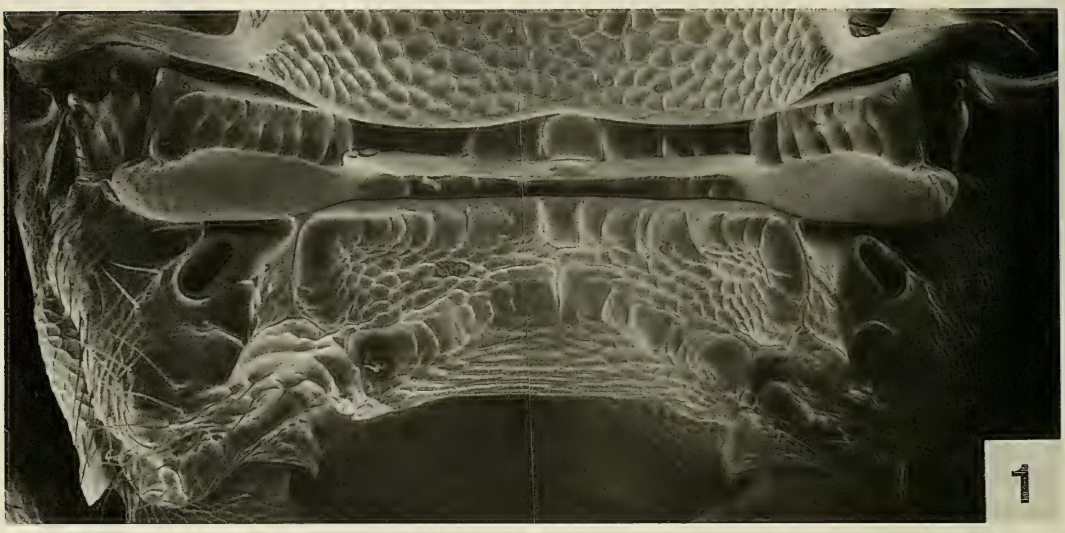

Fig. 1. *Pteromalus elevatus,* composite scanning electron photomicrograph. Propodeum, 65×.

The large and diverse genus *Pteromalus* Swederus (including *Habrocytus* Thomson, see Bouček and Graham 1978a) contains about 100 species in the western Palearctic region (Bouček and Rasplus 1993), and another 40 species in the Nearctic region (Burks 1979). *Pteromalus elevatus* is a member of the *albipennis* group, which includes about 30 Palearctic species (*sensu* Graham 1969).

The female of *P. elevatus,* which is illustrated by Varley (1947: 165) and Redfern (1983: Pl. 7, Fig. 2), can be readily distinguished from those of native Nearctic species of the genus by the combination of its larger body size (2.5–5.5 mm), its host preferences (gall-forming tephritids in flowerheads of composites), and its unique propodeal structure (Fig. 1).

Females (Fig. 2) (and males) of this adventive species are characterized as follows: Head, thorax, and abdomen dark metallic green; coxae and all, except apices of, femora metallic green; tibiae and apices of femora brown, tibiae centrally infuscate; tarsi yellowish, last segment dark brown. Anterior margin of clypeus at most moderately deeply emarginate. Antenna with combined length of pedicellus and flagellum slightly less than width of head; proximal segments of funicle quadrate, the first usually at least very slightly shorter than pedicellus; scape reaching at most to level of lower edge of median ocellus. Head hardly wider than mesonotum. Scutellum discally finely to very finely reticulate. Forewing with row of hairs on lower surface of costal cell complete; postmarginal vein of forewing as long as or slightly longer than marginal vein. Propodeum (Fig. 1) without a costula; panels of median area quite strongly sculptured, for the most part very finely reticulate; median carina raised to form a tooth subbasally. Gaster 1.1–1.6 times as long as head plus thorax; at least 2.5 times as long as broad.

Distribution.—In the Palearctic region, *P. elevatus* is widely distributed throughout most of western Europe, including Great Britain, Sweden, Czechoslovakia, and portions of the former Soviet Union (Moldavia) (Graham 1969).

In North America (Map 1), *P. elevatus* is currently known only from the following localities in New Brunswick (from a North American literature record), Newfoundland (from a European literature record), and Nova Scotia (from our own collecting):

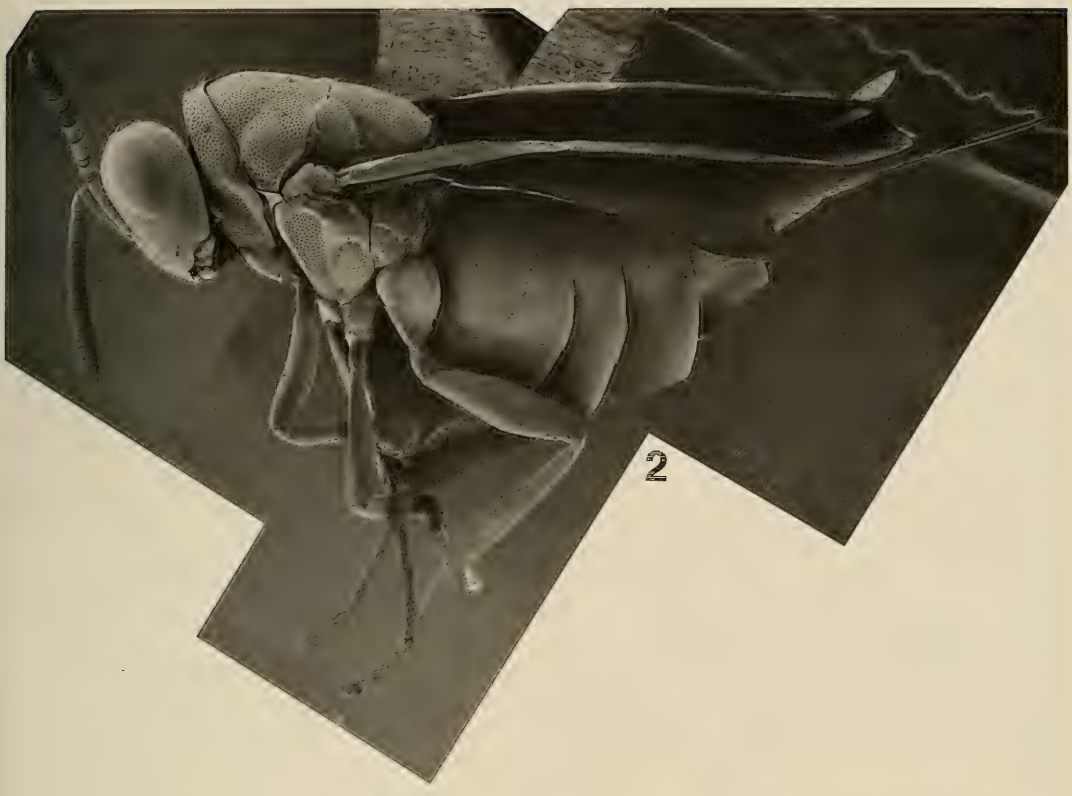

Fig. 2. *Pteromalus elevatus,* composite scanning electron photomicrograph. Female habitus, lateral aspect, 35×.

New Brunswick: "Sussex Corner, IV-1979, ex *Urophora cardui* galls on Canada thistle shoots" (see Peschken et al. 1982: 353). **Newfoundland:** "St. John's, 12-V-1958, R. F. Morris, ex knapweed seed pod" (see Graham 1969: 540). **Nova Scotia:** *Cape Breton Co.,* Cape Breton Isl., Louisbourg, 24-VII-1995; North Sydney, 24-VII-1995; Sydney, 23-VII-1995. *Colchester Co.,* Truro, 22-VII-1995. *Digby Co.,* Digby, 20-VII-1994. *Halifax Co.,* Halifax, 26-VI-1993, 20-21-VII-1995. *Inverness Co.,* Cape Breton Isl., Port Hawkesbury, 23-VII-1995. *Kings Co.,* Kentville, 21-VII-1994. *Lunenburg Co.,* Lunenburg, 19-VII-1994, 21-VII-1995. *Shelburne Co.,* Shelburne, nr. marine terminal, 19-VII-1994. *Yarmouth Co.,* Yarmouth, 20-VII-1994.

Specimens that served as the basis for the Newfoundland and New Brunswick literature records are deposited in the Canadian National Collection of Insects (CNCI, Ottawa). All Nova Scotian specimens were collected or observed by the authors on flowerheads of black knapweed (*Centaurea nigra*); voucher specimens are deposited in the Cornell University Insect Collection (CUIC, Ithaca, NY) and the U.S. National Museum of Natural History (USNM, Washington, DC).

Hosts and natural history.—In western Europe, *P. elevatus* is a parasitoid of seedhead tephritids on certain Asteraceae (= Compositae). Its natural history has been studied by Varley (1947) in Great Britain (as *Habrocytus trypetae* Thomson), who recorded it as an ectoparasitoid of *Urophora jaceana* in galled florets of black knapweed (cited as *Centaurea nemoralis* Jord.), and by Redfern (1983), also in the British Isles,

Map 1. Known distribution of *Pteromalus elevatus* in eastern North America. A, literature record from Graham (1969: 540); B, literature record from Peschken et al. (1982: 353); all other records from authors' collecting.

who recorded it as one of two common ectoparasitoids of *U. stylata* in galled shoots of bull (= spear) thistle (*Cirsium vulgare* (Savi) Tenore).

Eggs are laid in gall cells containing larvae and pupae of the gall fly, or in gall cells already containing other parasitoids. Numerous eggs may be laid on a single host, but usually only one larva matures because newly emerging larvae destroy any other eggs or larvae they encounter. The parasitoid is not host specific and may attack larvae of the eurytomid *Eurytoma curta* Walker and other parasitoids. Depending on climatic conditions, 2–3 generations are produced annually. *Pteromalus elevatus* typically emerges in May and August, and is able to locate numerous gall fly larvae at a stage suitable for parasitism. Newly emerged sexually immature females first feed on the host without laying eggs. The ovipositor is pushed down through the neck of the flask-shaped gall until it stabs a host, which is stung and paralyzed. A secretion hardens around the ovipositor to form a tube through which the hemolymph of the host exudes; the female parasitoid then feeds on the hemolymph. Females generally do not attack the nongall-forming tephritids in knapweed. Adults are found in the field from May until August or occasionally September.

Pteromalus elevatus has also been recorded as a parasitoid of the tephritid gall

flies *Terellia serratulae* (L.), *Urophora cardui* (L.), *U. stylata* (F.), *Noeeta pupillata* (Fallén), and the tortricid moth *Sparganothis pilleriana* Schiffermüller. This parasitoid has been reared from flowerheads of species in the composite genera *Centaurea, Carduus, Cirsium, Arctium,* and *Hieracium.* Because of the difficulty in accurately identifying species of *Pteromalus,* some of these rearing records are probably doubtful (Varley 1947, Peschken et al. 1982, Redfern 1983).

Mode of introduction.—North American populations of *P. elevatus* may have originated from the accidental introduction of the gall fly *U. jaceana,* one of its principal hosts, or with the intentional releases of *U. cardui* in eastern Canada. Larvae of *U. jaceana* live in the flowerheads of black knapweed (*C. nigra*), a species also introduced from Europe and now widespread in the Maritime provinces, the Gaspé, Ontario, British Columbia, and the eastern United States. No doubt the gall fly was accidentally introduced with its host plant; it was first collected in North America in 1923 at Kentville, Nova Scotia, and in 1949 at St. John's, Newfoundland (Shewell 1961).

Possible effects on *Urophora* spp. introduced for biological control.—*Urophora affinis* (Frauenfeld) and *U. quadrifasciata* (Meigen), introduced into the Pacific Northwest for the biological control of pestiferous knapweeds (*Centaurea* spp.), have been able to attain higher densities than in Europe partly because they lack parasitoid enemies in North America (Myers and Harris 1980). These *Urophora* spp., as well as *U. sirunaseva* Hering, which was introduced into the western United States to control yellow starthistle (*C. solstitialis* L.) (Turner et al. 1994), are not known hosts of *P. elevatus.* Thus, even if this parasitoid should become established in areas occupied by *Urophora* spp. imported for knapweed control, there appears to be little risk of adverse effects on tephritid populations. Moreover, these seedhead flies, by themselves, have not reduced densities of target knapweeds in western North America (e.g. Harris and Cranston 1979, Harris 1980). As a natural enemy of the unintentionally introduced *U. jaceana, P. elevatus* poses little or no threat to biological control of weed projects in North America except for possible minor effects on *U. cardui,* a tephritid that has placed little stress on populations of Canada thistle (Peschken et al. 1982).

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ESTABLISHMENT OF *UROPHORA AFFINIS* ON SPOTTED KNAPWEED IN PENNSYLVANIA, WITH NEW EASTERN U.S. RECORDS OF *U. QUADRIFASCIATA* (DIPTERA: TEPHRITIDAE)

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Abstract.—The Old World tephritid *Urophora affinis* (Frauenfeld) is a gall-inducing seedhead fly released in western and eastern North America for the biological control of knapweeds, *Centaurea* spp. (Asteraceae). Its establishment and spread in the West are well documented, but recoveries in the East have been few: in New York near release sites in Essex and Warren counties and at unspecified localities in Quebec and Virginia (presumably at or near release sites). *Urophora affinis* is reported as a new state record from Pennsylvania (7 counties), and its establishment in central New York State is recorded. *Urophora quadrifasciata* (Meigen), another Palearctic species introduced for knapweed control, is recorded for the first time from Maryland, Virginia, and West Virginia, and its known range in Pennsylvania is extended.

Key Words: Insecta, Tephritidae, seedhead flies, distribution, spotted knapweed, biological control

The tephritid genus *Urophora* includes about 100 species whose larvae are nearly always associated with plants of the Asteraceae. Eight species are indigenous to the Nearctic Region, and three Eurasian species—*U. affinis* (Frauenfeld), *U. quadrifasciata* (Meigen), and *U. sirunaseva* (Hering)—have been introduced to North America for the biological control of adventive knapweeds, *Centaurea* spp. (White and Korneyev 1989, Turner et al. 1994). Several members of this composite genus infest rangelands and pastures in western North America (Watson and Renney 1974, Maddox 1979, Strang et al. 1979, Harris and Myers 1984, Müller-Schärer and Schroeder 1993). The most economically important species in the West are diffuse knapweed, *C. diffusa* Lam., and spotted knapweed, *C. biebersteinii* DC. (= *C. maculosa* of American authors) (Harris and Myers 1984, Müller et al. 1988, Kartesz 1994). Spotted knapweed is also common in the Northeast (USDA 1971, Gleason and Cronquist 1991).

Urophora affinis and *U. quadrifasciata* are seedhead flies whose larvae feed in buds and in flower heads of their herbaceous hosts, with females of *U. affinis* ovipositing in smaller heads than those of *U. quadrifasciata.* Larvae of the two species are able to coexist in capitula of their hosts (Berube 1980, Harris 1980a, Shorthouse 1990). The mostly univoltine *U. affinis* induces a complex gall from tissues of the ovary and receptacle; the thinner, more simple gall of *U. quadrifasciata,* a predominantly bivoltine species, is restricted to tissues of the ovary wall (Shorthouse 1978a, b, 1990, Story et al. 1992). Galls of *U. af-*

finis are greater energy sinks than those of *U. quadrifasciata,* reducing seed production even in uninfested capitula (Harris 1980b, Myers and Harris 1980, Shorthouse 1990). Despite negative interaction between these biological control agents, their effects on host plants are complementary, and knapweed seed is reduced more in areas where the flies coexist (Berube 1980, Harris 1980b, Myers and Harris 1980, Harris and Myers 1984).

Following initial releases of both tephritids in British Columbia in the early 1970s, their establishment in that province and the western United States (Washington to California plus Idaho and Montana) has been well documented (Maddox 1979, 1982, Harris and Myers 1984, Story et al. 1987, Julien 1992, Foote et al. 1993, Hoebeke 1993, Müller-Schärer and Schroeder 1993). They were also released in eastern North America: *U. affinis* in Ontario (1970–1971), Quebec (1979–1980), Maryland, New York (1983), and Virginia (1985–1986); and *U. quadrifasciata* in Quebec (1979), Maryland, and New York (1983) (Harris and Myers 1984, Julien 1992, Hoebeke 1993). Postrelease monitoring in the East, however, has been less thorough than in western North America. Not until the early 1990s was the eastern establishment of either species reported. Based on surveys during 1990 to 1992 (Hoebeke 1993), *U. quadrifasciata* was found to be widespread from New England (Connecticut, Massachusetts, New Hampshire, Rhode Island, and Vermont) south to New York, New Jersey, and Pennsylvania. No specimens of *U. affinis,* however, were collected from *Centaurea* spp. during surveys for *U. quadrifasciata* in the Northeast, although recoveries had been reported at release sites in Essex and Warren counties, N.Y., in 1985 (Foote et al. 1993, Hoebeke 1993). The only other eastern records of *U. affinis* are Quebec and Virginia, cited without specific localities by Julien (1992).

Here we give the first records of *U. affinis* from Pennsylvania, document its establishment in central New York, and speculate on the origin of these populations. We also provide the first records of *U. quadrifasciata* from Maryland, Virginia, and West Virginia, and extend its previously recorded distribution in Pennsylvania.

Methods

Urophora affinis.—The first Pennsylvania specimens were collected at Tamaqua (Schuylkill Co.), Pa., on 23 June 1994. In late June we began surveying spotted knapweed colonies observed within 50–60 km of the detection site in an attempt to delimit the fly's distribution in eastern Pennsylvania. Capitula of knapweed growing on shaly roadside banks, in road maintenance or construction spoils, along railroad rights-of-way, in urban vacant lots, and in other disturbed sites were swept with a standard insect net. The number of sweeps varied with colony size but usually consisted of at least several hundred. Any *U. affinis* adults observed were collected for laboratory verification of tentative field identifications. Our surveys apparently were initiated before adult populations had begun to decline, based on the presence of greater numbers of males than females, or at least about equal numbers of both sexes; males tend to emerge earlier (Story and Anderson 1978). Surveys continued until late August, although no adults were seen after mid-July. Similar, but less extensive, sampling of knapweed was conducted in 1994 in north-central Pennsylvania (A.G.W., C.A.S.) and in central and south-central New York (E. R. Hoebeke, A.G.W.). In 1995, additional delimiting surveys were made in eastern Pennsylvania (A.G.W.).

Urophora quadrifasciata.—Spotted knapweed was sampled during 1994-1995 in portions of Maryland, Virginia, and West Virginia—states from which this tephritid's establishment had not been previously recorded. Limited sampling was also conducted in several western Pennsylvania counties where this species had not been found in earlier surveys (Hoebeke 1993).

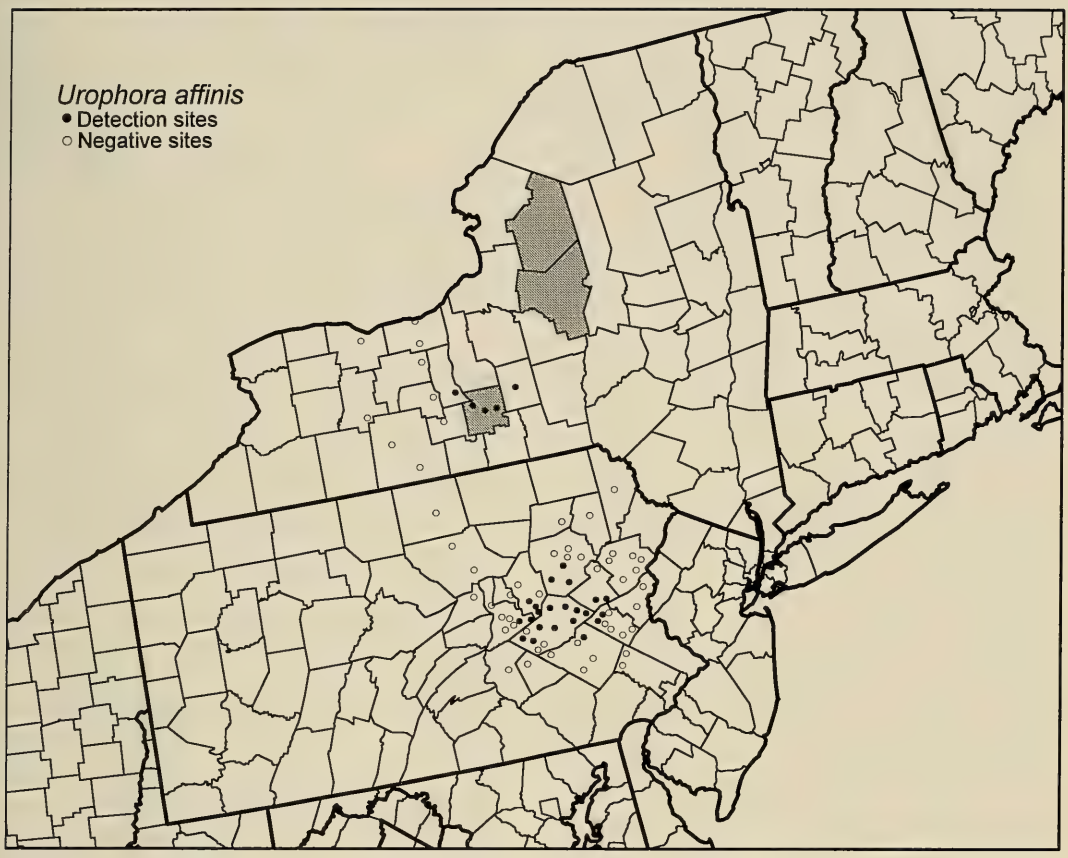

Fig. 1. Known distribution of *Urophora affinis* in New York and Pennsylvania. Shading indicates counties in which biological control releases were made; release sites in eastern Canada, Maryland, and Virginia are not shown.

Voucher specimens of both species have been deposited in the Cornell University Insect Collection, Ithaca, NY (CUIC) and Pennsylvania Department of Agriculture Insect Collection (PADA); specimens of *U. affinis* have been deposited at the National Museum of Natural History, Washington, DC (USNM).

Results

Urophora affinis.—The following records, representing the first for Pennsylvania and first for New York except recoveries at release sites in the Adirondacks, extend the known distribution of *U. affinis* in eastern North America (Fig. 1). All Pennsylvania collections were made by the authors in 1994 (except Northumberland Co., 1995) from *Centaurea biebersteinii.* New York collections were made in 1994 by E. R. Hoebeke from the same plant species.

NEW YORK: *Cortland Co.,* Cortlandville, 2 July; *Seneca Co.,* 1 mi. N. of Interlaken, 3 July; *Tompkins Co.,* Dryden, Ithaca, and Taughannock Falls State Park, 2–4 July. PENNSYLVANIA: *Berks Co.,* Hamburg, 5 July; *Carbon Co.,* Bowmanstown, 11 July; Jim Thorpe, 23 June; *Columbia Co.,* Aristes, Centralia, and 6 mi. S. of Numidia, 1 July; *Lehigh Co.,* Jacksonville, New Tripoli, 5 July; *Luzerne Co.,* Rt. 81 nr. Dorrance exit, 30 June; Hazleton, 23 June; Nescopeck, 27 June; *Northumberland Co.,* Coal Twp. N. of Shamokin, 13 June; Mount Carmel, 6 July; *Schuylkill Co.,* NE. of Barnesville, 30 June; Frackville, 23 June;

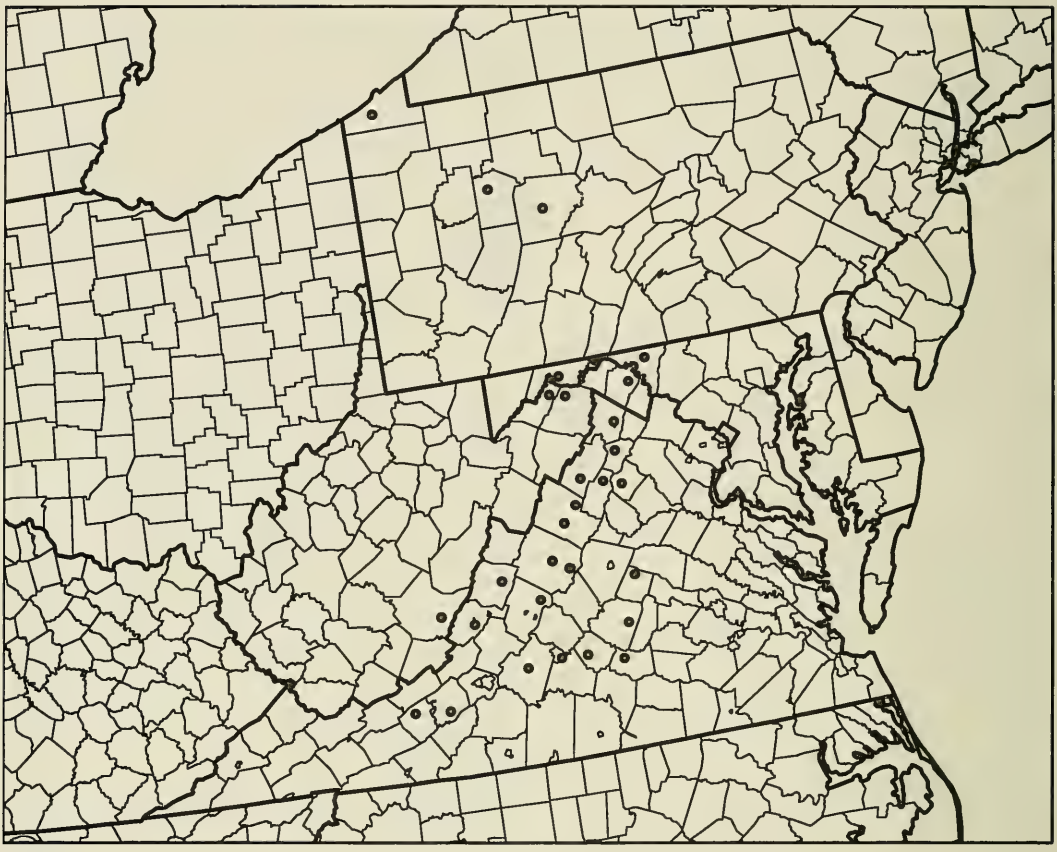

Fig. 2. New records of *Urophora quadrifasciata* in eastern United States.

Hegins, 29 June; Llewellyn, 7 July; N. of Mahanoy City, 27 June; New Ringgold, 5 July; Pottsville, 7 July; Tamaqua, 23 June, 7 July; Rt. 209 N. of Tamaqua, 23 June; Tremont, 7 July.

Urophora quadrifasciata.—The known eastern distribution is extended to include Maryland, Virginia, and West Virginia, as well as additional counties in western Pennsylvania (Fig. 2). All collections were made in 1994–1995 by A.G.W. from *C. bieberstеinii.*

MARYLAND: *Allegany Co.,* Oldtown, 2 July; *Washington Co.,* Hagerstown, 26 June; Hancock, 2 July. PENNSYLVANIA: *Clearfield Co.,* Rt. 879 NE. of Clearfield, 12 July; *Erie Co.,* Rt. 832 nr. junc. Rt. 90, SW. of Erie, 13 July; *Jefferson Co.,* Brookville, 12 July. VIRGINIA: *Alleghany Co.,* Covington, 26 June; *Appomattox Co.,* Rt. 460, Spout Springs, 3 July; *Augusta Co.,* Staunton, 25 June; Waynesboro, 3 July; *Bath Co.,* Rt. 39 E. of Millboro Springs, 3 July; *Bedford Co.,* Bedford, 3 July; *Buckingham Co.,* Sprouses Corner, 4 July; *Campbell Co.,* Lynchburg, 3 July; *Fluvanna Co.,* SW. of Zion X-Roads, 4 July; *Frederick Co.,* Winchester, 26 June; *Montgomery Co.,* Christiansburg, 26 Aug.; *Page Co.,* Luray, 7 Aug.; *Prince Edward Co.,* nr. Prospect, 3 July; *Pulaski Co.,* Dublin, 3 July; *Rappahannock Co.,* Rt. 211 nr. Thornton Gap and Page Co. line, 7 Aug.; *Rockbridge Co.,* Fairfield, 3 July; *Rockingham Co.,* Broadway, 25 June; Harrisonburg, 4 July; *Shenandoah Co.,* Mount Jackson, 26 June; *Warren Co.,* Rt. 55, 3 mi. E. of Strasburg, 7 Aug. WEST VIRGINIA: *Berkeley*

Co., Martinsburg, 26 June; *Greenbrier Co.,* Rt. 311 E. of White Sulphur Springs, 4 July; *Hampshire Co.,* Springfield, 2 July; *Mineral Co.,* Short Gap, 2 July.

Discussion

The southward spread of *U. quadrifasciata* into Maryland, Virginia, and West Virginia might have been predicted given the large numbers encountered during surveys in south-central Pennsylvania in the early 1990s (Hoebeke 1993, A.G.W., personal observations). Natural dispersal from the north would seem responsible for the more southern populations of this tephritid.

In contrast, populations of *U. affinis* in eastern North America, at least in Pennsylvania, are more limited in their extent than those of *U. quadrifasciata.* Our sampling of spotted knapweed, although based strictly on sweepnet collecting of adults, was sufficient to detect this fly at 22 other localities near the site of its initial capture; at most sites only 1–5 individuals were observed. Surveys were generally negative for *U. affinis* at sites outside an apparent core population centered in Schuylkill Co. (Fig. 1), even though the size of knapweed colonies and sampling intensity were equivalent. Negative localities are shown in Fig. 1 only if there seemed to be a reasonable chance of collecting adults (until about mid-July). We also failed to detect populations in northern Pennsylvania and south-central New York, as well as in Maryland, Virginia, and West Virginia.

Densities of *U. affinis* adults in Pennsylvania were not assessed, but field estimates indicated that at least during late June to mid-July they were typically outnumbered 10–20:1 by *U. quadrifasciata.* Only at Pottsville on 7 July 1994 was *U. affinis* dominant: about 100 adults vs 4–5 of *U. quadrifasciata*; by late July the latter species was abundant and no *U. affinis* were found. Tamaqua was the only other site at which more than 10 *U. affinis* adults were observed. No *U. affinis* were seen after mid-July, and there was no evidence of a second generation.

All available information suggests that *U. affinis* has only recently become established in Pennsylvania. We collected adults of this species at several sites that yielded *U. quadrifasciata* in Pennsylvania and New York during 1990–1992 (see Hoebeke 1993). Had *U. affinis* been present in similar numbers during the early 1990s, it most likely would have been detected at one of the sites that falls within its current known range in those two states.

Populations of *U. affinis* found in the Ithaca, N.Y., area in 1994 may be the result of previous releases (1983) in Tompkins County. Densities much lower than at present could possibly have gone unnoticed during Hoebeke's (1993) surveys.

The origin of Pennsylvania populations of *U. affinis* is even more problematic. No releases have been documented for the state; Prince George's Co., Md., and Tompkins Co., N.Y., are the nearest known release sites. *Urophora affinis,* however, is not known to be established in Maryland (P. W. Tipping, pers. comm. 1994), and we did not find it in that state in 1994 during limited sampling of spotted knapweed in Allegany and Washington counties. If populations in eastern Pennsylvania are the result of natural dispersal from central New York, the fly could be expected to occur in the intervening area. It was not, however, found immediately north and northwest of Schuylkill Co., Pa.; nor was it detected at various other sites in New York and Pennsylvania (Fig. 1).

Urophora affinis (and *U. quadrifasciata*) can be purchased from suppliers of biological control agents, but because there is little interest in controlling spotted knapweed in the East (N. Poritz, pers. comm. 1994), the possibility of this tephritid's establishment from releases by private citizens or local governments seems unlikely. Other alternatives are long-distance aerial transport, either active or passive, from established populations in New York or Virginia, or

through the accidental introduction of infested knapweeds via commerce.

Regardless of their origin, the eastern North American populations of *U. affinis* provide an additional opportunity to evaluate long-term interactions with *U. quadrifasciata.* In the West, the latter biocontrol agent initially spread more rapidly, colonizing even remote knapweed stands (Harris 1980a, Harris and Myers 1984, Story et al. 1987, Story et al. 1992). But *U. affinis* proved the more persistent of the two species and has generally become dominant at sites where they co-occur. This is also the case in Europe (Berube 1980, Story et al. 1992).

Urophora quadrifasciata disperses more readily than *U. affinis* (but does not show greater flight propensity or endurance in laboratory studies [Roitberg 1988]) and has potential for more rapid population increase. These advantages tend to be offset by the lack of unopened inflorescences available in late summer. In contrast, the univoltine *U. affinis* emerges when flower buds of its hosts are abundant, and it consequently has less pressure to disperse. Its attacks on knapweed retard further development of capitula, placing the mainly bivoltine, later-emerging *U. quadrifasciata* at a competitive disadvantage (Berube 1980, Harris and Myers 1984, Story et al. 1992).

These seedhead flies by themselves cannot be expected to reduce host plant densities in the East. They have not done so in western North America (Harris and Cranston 1979, Harris 1980a, Maddox 1982, Story et al. 1989), and a "cumulative stress" approach combining biological control with other management techniques will be needed to achieve successful control (Müller-Schärer and Schroeder 1993). Nevertheless, these tephritids should be considered beneficial in the East, their combined attacks on spotted knapweed likely resulting in reduced seed production similar to that documented in the West (Harris 1980a, 1984; Harris and Myers 1984). Their populations should be monitored to determine whether *U. affinis* becomes the dominant tephritid species in most eastern knapweed stands.

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PLANTHOPPERS OF PITCH PINE AND SCRUB OAK IN PINE BARRENS COMMUNITIES (HOMOPTERA: FULGOROIDEA)

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Abstract.—Planthoppers were collected in northeastern pitch pine-scrub oak barrens, the New Jersey Pine Barrens, and in ridgetop pine barrens from Maine to Virginia. The host plants were pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*) except for one species taken on sheep laurel (*Kalmia angustifolia*). Fourteen species of Fulgoroidea were collected: 7 species in 3 genera of Achilidae, 4 species in 3 genera of Cixiidae, 2 species in 2 genera of Derbidae, and 1 species of Issidae. Five planthoppers collected consistently from northeastern pine barrens can be considered characteristic of these insect-rich natural communities. The new species ***Myndus wheeleri*** Wilson from New Jersey is described and illustrated.

Key Words: Insecta, Homoptera, distribution, host plants, North America

The term pine barrens, used in a broad sense, refers to natural shrub-savannah communities that consist of open pitch pine (*Pinus rigida* Mill.) woodlands having an understory of shrubby oaks (*Quercus ilicifolia* Wangenh. and sometimes *Q. prinoides* Willd.); various heaths (Ericaceae); as well as wildflowers, grasses, and other herbs. These disclimax, fire-dependent communities typically occur on sandy, excessively well-drained, nutrient-poor soils—on deep sandy deposits on the Coastal Plain, and inland on glacial till and outwash plains. Northeastern pitch pine-scrub oak barrens and their variants or subtypes (e.g., boreal, coastal, and midlatitude inland) can be considered postglacial relicts. They represent a globally imperiled community type distinct from the better-known New Jersey Pine Barrens, which are characterized by a more southern flora and a mosaic of vegetation types differing from those of northeastern pine barrens. Similar communities are found on ridgetops, but these barrens are generally not as floristically diverse as more lowland barrens and tend to have a more depauperate insect fauna (Olsvig et al. 1979, Cryan 1985, Rawinski 1987, Schweitzer and Rawinski 1987, Widoff 1987, Reschke 1990, Wheeler 1991, Dirig 1994).

The New Jersey Pine Barrens (e.g., Boyd and Marucci 1979, Boyd 1973, 1991), Albany Pine Bush (Rittner 1980, Stewart and Rossi 1981), and Long Island Pine Barrens (Cryan 1980) have long been favored collecting areas for naturalists and entomologists, particularly lepidopterists. In addition to an interest in characteristic lepidopterans such as the Karner blue butterfly, *Lycaeides melissa samuelis* Nabokov (Dirig 1976, Stewart and Ricci 1988, Andow et al. 1994), and buck moth, *Hemileuca maia* (Drury) (Cryan and Dirig 1977, Cryan 1985), there has been an increasing appreciation of pine barrens as communities that harbor an exceptionally rich lepidopteran

fauna, including numerous species that do not occur in nearby deciduous forests (Cryan 1980, Rawinski 1987, Schweitzer and Rawinski 1987, Widoff 1987). The Nature Conservancy and several State Natural Heritage Programs have recently placed an emphasis on documenting the biotic diversity of pine barrens and related communities.

During a study of plant bugs (Hemiptera: Miridae) associated with *Quercus ilicifolia* (Wheeler 1991) and *Pinus rigida* (AGW, unpublished data), planthoppers representing several families were consistently observed on these two dominant pine barrens plants. Because the Fulgoroidea of pine barrens have received little attention, the planthoppers occurring on scrub oak and pitch pine were collected in northeastern pitch pine-scrub oak barrens and related communities. Herein we record the adult achilids, cixiids, derbids, and issids encountered during the survey (mainly 1990–1992), including one species collected on sheep laurel (*Kalmia angustifolia* L.), and describe the new species *Myndus wheeleri* Wilson (Cixiidae) from the New Jersey Pine Barrens.

Methods and Study Sites

Planthoppers were beaten from branches of scrub oak and pitch pine (with one collection from sheep laurel) as described by Wheeler (1991), and all adults collected were identified by SWW. The sites sampled included many of those used in the study of mirids associated with scrub oak (Wheeler 1991): the Albany Pine Bush, New Jersey Pine Barrens, various other northeastern pitch pine-scrub oak barrens, and ridgetop barrens such as New York's Shawangunk Mountains. The description of the new species *Myndus wheeleri* follows the format used by Kramer (1979).

Achilidae

Nymphal achilids are presumed to feed on fungi or decaying vegetation, as they have usually been collected under the bark of logs (Hepburn 1967, Wilson et al. 1994). Adults feed on plant sap and have been associated with numerous angiosperms and gymnosperms. Slightly over half of the known adult host records indicate a tendency toward polyphagy; slightly fewer than half suggest a more restricted host plant range for those species (Wilson et al. 1994). Host plant records of adults of nine species of *Catonia* include 11 plant families; 6 of the species have been recorded from *Pinus* spp. *Epiptera* adults have been collected beneath the bark of dead hardwood and conifers as well as in sawdust piles (Hepburn 1967, Wilson 1983). Three species appear to be associated with pines (Hepburn 1967). Host records for 17 species of *Synecdoche* include 13 plant families; 5 of the species have been associated with Pinaceae and 7 with Ericaceae (Wilson et al. 1994).

Catonia cinctifrons (Fitch)

Distribution: Massachusetts south to Florida and west to Iowa and Texas (O'Brien 1971).

Pine Barrens records: NEW YORK: Clinton Co., NE Ausable Chasm, 30 Aug 1992, ex *Pinus rigida,* 1 female. WEST VIRGINIA: Greenbrier Co., Kates Mtn., White Sulphur Springs, 25 Aug 1990, ex *Quercus ilicifolia,* 4 males.

Host plant records: *Pinus clausa, Pinus* sp., *Quercus* sp., *Carya* sp. (Wilson et al. 1994).

Catonia picta Van Duzee

Distribution: Coastal from Connecticut south to Florida and west to Louisiana (O'Brien 1971).

Pine Barrens records: NEW JERSEY: Burlington Co., Rt. 72 W Rt 539, NW Warren Grove, 11 Aug 1991, ex *Pinus rigida,* 4 males, 1 female.

Host plant records: *Pinus* sp. (Wilson et al. 1994).

Catonia pumila Van Duzee

Distribution: Massachusetts south to Georgia and west to Minnesota and Louisiana (O'Brien 1971).

Pine Barrens records: CONNECTICUT: Hartford Co., Shaker Pines, Enfield, 28 Sept 1991, ex *Pinus rigida,* 3 females. MASSACHUSETTS: Franklin Co., Montague Sand Plains, 14 Sept 1991, ex *Pinus rigida,* 8 females. NEW YORK: Clinton Co., W. Chazy Jack Pine Barrens 29 Aug 1992, ex *Pinus rigida* cones, 3 males, 1 female; Clintonville Sand Plain, 30 Aug 1992, ex *Pinus rigida,* 4 males, 8 females; NE Ausable Chasm, 30 Aug 1992, ex *Pinus rigida,* 5 males, 2 females. Saratoga Co., Rt. 9 junction Rt 197, 3 mi. S South Glens Falls, 22 Aug 1992, ex *Pinus rigida,* 2 males, 1 female. Albany Co., Pine Plaza W., Albany, 22 Aug 1992, ex *Pinus rigida,* 1 male. RHODE ISLAND: Washington Co., Arcadia Management Area, 1 Sept. 1991, ex *Pinus rigida,* 1 female.

Host plant records: *Pinus* sp., *Quercus* sp., *Carya* sp. (Wilson et al. 1994).

Epiptera brittoni Metcalf

Distribution: New Brunswick south to North Carolina and west to British Columbia (Beirne 1950, S.W.W., unpubl. data).

Pine Barrens records: RHODE ISLAND: Kent Co., Trestle Trail, nr. Greene, 5 August 1990, ex *Quercus ilicifolia,* 1 female.

Host plant records: *Picea* spp., *Abies* spp., *Pseudotsuga menziesii* (Mirb.) Franco, *Tsuga heterophylla* (Raf.) Sarg., *Pinus* spp. (Brown 1941).

Epiptera variegata (Van Duzee)

Distribution: Quebec south to North Carolina and west to Ontario and Illinois (Beirne 1950).

Pine Barrens records: MASSACHUSETTS: Hampden Co., Barnes Mun. Airport, nr. Westfield, 14 Sept 1991, ex *Pinus rigida,* 1 male. PENNSYLVANIA: Schuylkill Co., Rt 25, 2.5 mi NW, Newtown, 4 Sept 1989, ex *Pinus rigida,* 1 male, 1 female.

Host plant records: *Picea glauca* (Moench.) Voss. (Brown 1941).

Synecdoche dimidiata (Van Duzee)

Distribution: Maine south to Florida and, in pine barrens habitats, west to Ohio (O'Brien 1971, present study).

Pine Barrens records: MAINE: York Co., Killick Pond Barrens, 8 Aug 1990, ex *Quercus ilicifolia,* 3 males, 5 females; Waterboro Barrens, 9 Aug 1990, ex *Quercus ilicifolia,* 2 females. PENNSYLVANIA: Monroe Co., Long Pond, 16–17 Aug. 1986, T. J. Henry and A. G. Wheeler, Jr., colls., ex *Quercus ilicifolia,* 4 males; Somerset Co., Mt. Davis, 10 Aug 1991, ex *Pinus rigida,* 1 male, 2 females. RHODE ISLAND: Kent Co., Trestle Trail nr. Greene, 5 Aug 1990, ex *Quercus ilicifolia,* 1 female. NEW YORK: Clinton Co., Ausable Chasm, 30 Aug 1992, ex *Pinus rigida,* 1 female. VIRGINIA: Augusta Co., Big Levels barren, 26 Aug 1990, ex *Quercus ilicifolia,* 1 male, 2 females. WEST VIRGINIA: Greenbrier Co., Kates Mtn., White Sulphur Springs, 25 Aug 1990, ex *Quercus ilicifolia,* 1 female.

Host plant records: *Pinus* sp., *Fagus* sp. (Wilson et al. 1994).

Synecdoche impunctata (Fitch)

Distribution: Quebec south to Georgia and west to Iowa and Oklahoma (O'Brien 1971).

Pine Barrens records: MAINE: Oxford Co., E. Brownfield, Fryeburg Barrens, 10 Aug 1990, ex *Quercus ilicifolia,* 1 male, 5 females; York Co., Shapleigh Barrens, 9 Aug 1990, ex *Quercus ilicifolia,* 1 male, 3 females; Waterboro Barrens, 9 Aug 1990, ex *Quercus ilicifolia,* 2 males, 1 female. MASSACHUSETTS: Franklin Co., Montague Barrens, 4 Aug 1990, ex *Quercus ilicifolia,* 2 females; Plymouth Co., Miles Standish State Forest, 5 Aug 1990, ex *Quercus ilicifolia,* 1 male, 3 females. NEW HAMPSHIRE: Carroll Co., Ossipee Barrens, 10 Aug 1990, ex *Quercus ilicifolia,* 1 male, 1 female. RHODE ISLAND: Kent Co., Trestle Trail nr. Greene, 5 Aug 1990, ex *Quercus ilicifolia,* 2 males.

Host plant records: *Quercus* spp., *Prunus* sp. (O'Brien 1971).

Cixiidae

Nymphal cixiids feed underground on plant roots, and possibly fungi, whereas adults feed above ground on plant sap (Wilson et al. 1994). Host plant records of adults of 10 species of North American *Cixius* include 8 plant families; 3 of the species have been recorded from *Pinus* spp. Host plant records of adults of 17 species of North American *Myndus* include 8 plant families; 9 of the species have been recorded from Agavaceae. Nymphs of *M. crudus* Van Duzee feed on several grasses (Poaceae); adults feed on palms (Arecaceae) and are vectors of the MLO that causes lethal yellowing disease (Wilson and O'Brien 1987, Wilson et al. 1994). Host plant records of adults of 10 species of North American *Oliarus* include 5 plant families; 2 of the species have been recorded from Pinaceae.

Cixius pini Fitch

Distribution: New Hampshire south to North Carolina and west to Minnesota and Tennessee (Kramer 1981).

Pine Barrens records: PENNSYLVANIA: Somerset Co., Mt. Davis, 30 June 1991, ex *Pinus rigida,* 1 male.

Host plant records: *Pinus* sp., *Picea* sp., *Abies* sp. (Kramer 1981), *Gaylussacia* sp. (Osborn 1938).

Cixius quebecensis Beirne

Distribution: Quebec south to Maine and New York (Kramer 1981, present study).

Pine Barrens records: NEW YORK: Ulster Co., Ice Caves Mtn., SE Ellenville, 14 June 1991, ex *Kalmia angustifolia,* 1 male, 2 females.

Host plant records: *Kalmia angustifolia* (present study).

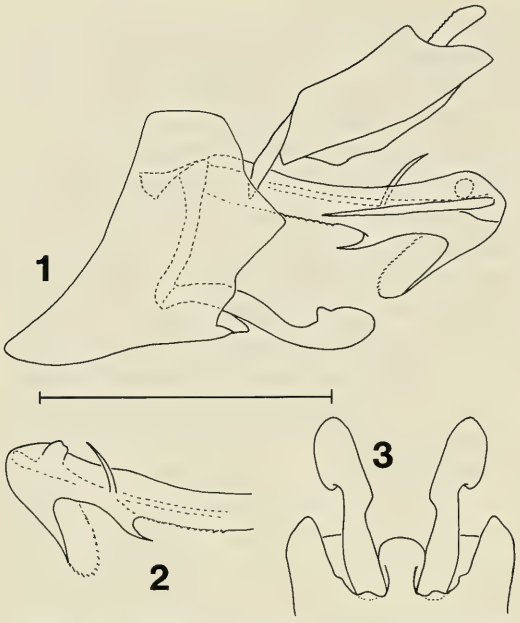
Myndus wheeleri Wilson, New Species
(Figs. 1–3)

Types: Holotype male with the following labels: "NJ: Burlington Co., Pine Barrens, Rt. 72 3 mi W. of Rt. 539, NW. Warren Grove, 4 July 1990," "taken in *Pinus rigida* cones," "A. G. Wheeler, Jr., Collector." Allotype female and 8 male and 8 female paratypes with same data; 1 paratype male collected same locality and host plant on 22 June 1991. Holotype, allotype, and 2 male and 2 female paratypes housed at National Museum of Natural History, Smithsonian Institution, Washington, D.C.; 2 male and 2 female paratypes housed at Snow Museum, University of Kansas, Lawrence; 2 male and 2 female paratypes housed at collection of S. W. Wilson; remaining paratypes deposited in the Cornell University Insect Collection, Ithaca, New York.

Salient features: Length ($\bar{x} \pm$ SD) of males 3.7 ± 0.16 mm (N = 9), females 3.8 ± 0.15 mm (N = 10). Ground color dark stramineous; males and females identical in color; vertex, frons, mesonotum, and pro- and mesothoracic legs slightly darker; pronotum, genae, coxae, and abdominal sternites lighter, almost yellow; forewings hyaline, translucent, veins dark with dark pustules.

Male genitalia (Figs. 1–3): Median lobe of pygofer in ventral view spatulate, broadly rounded at apex, apices of styles broadly rounded; genital capsule in lateral view with posterior margin strongly triangular, style capitate, anal flap with posteroventral apex almost acute and with membrane projecting between ventral margins; aedeagus in left lateral view with large apical appendage bearing teeth on anterior aspect, with elongate anteriorly directed spine extending about half length of aedeagus; aedeagus in right lateral view with slender upright process in anterior half, with anteriorly directed acute process on aedeagal shaft on ventral aspect near middle of shaft, ventral aspect serrate anterior to acute process.

Notes: The sharply triangular posterior margin of the pygofer, the shapes of the anal flap and styles, and the orientation of the dorsal and lateral processes ally this species with *M. pusillus* Van Duzee. It differs from *M. pusillus* in the presence of a



Figs. 1–3. Male genitalia of *Myndus wheeleri* Wilson. 1, Complete genitalia, left lateral view. 2, Aedeagus, right lateral view. 3, Apex of pygofer and styles, ventral view. Bar = 0.5 mm.

strong, acute process on the ventral aspect of the aedeagal shaft and the serrate region anterior to this process. Adults were collected from inside previous seasons' cones on *Pinus rigida,* where they were unlikely to have been feeding and were probably seeking shelter as in some achilids which hide in the dry fronds of palms during the day and leave to feed on green foliage at night (O'Brien, personal comm.). Field notes indicate that adults were abundant; 15–20 were observed in a single cone. This planthopper is named in recognition of Dr. A. G. Wheeler Jr.'s contributions to our knowledge of planthopper biology.

Oliarus quinquelineatus (Say)

Distribution: Nova Scotia south to Florida and west to Ontario, Colorado and Louisiana (Mead and Kramer 1982).

Pine Barrens records: MASSACHUSETTS: Franklin Co., Montague Sand Plains, 15 June 1991, ex *Pinus rigida,* 1 male, 3 females. Hampden Co., Barnes Municipal Airport, nr. Westfield, 16 June 1991, ex *Pinus rigida,* 1 male, 3 females. Plymouth Co, Miles Standish State Forest, 4 July 1991, ex *Pinus rigida,* 2 males, 4 females. NEW JERSEY: Burlington Co., Rt. 532, 3 mi. W. Chatsworth, 22 June 1991, ex *Pinus rigida,* 1 male, 1 female. NEW YORK: Albany Co., Rt. 155, Karner, Pine Bush, 14 June 1991, ex *Pinus rigida,* 1 male, 2 females. Steuben Co., NW of West Cameron, 9 July 1994, ex *Pinus rigida,* 2 males, 1 female. Ulster Co., Ice Caves Mtn., SE Ellenville, 14 June 1991, ex *Pinus rigida,* 1 male, 1 female; Mohonk Preserve, Overcliff Rd., nr. New Paltz, 2 June 1991, ex *Pinus rigida,* 4 males, Mohonk Preserve, nr. New Paltz, 3 July 1991, ex *Pinus rigida,* 2 males, 3 females. PENNSYLVANIA: Chester Co., Nottingham Park, 23 June 1991, ex *Pinus rigida,* 4 males, 4 females; Goat Hill Barrens, SW Nottingham, 23 June 1991, ex *Pinus rigida,* 7 males, 3 females. RHODE ISLAND: Washington Co., Arcadia Management Area, Rt. 165, 20 June 1993, ex *Pinus rigida,* 3 males; 7 July 1991, ex *Pinus rigida,* 1 male, 4 females.

Host plant records: "Hard pine" (*Pinus rigida*) in the Albany Pine Bush during July–August, 1901 (see Rittner 1979).

Oliarus spp.

Pine Barrens records: MASSACHUSETTS: Franklin Co., Montague Sand Plains, 15 August 1991, ex *Pinus rigida,* 6 females; 4 July 1991 ex *Pinus rigida,* 3 females. Hampden Co., Barnes Mun. Airport, nr. Westfield, 4 July 1991, ex *Pinus rigida,* 1 female. NEW JERSEY: Burlington Co., Rt. 72 W Rt 539, NW Warren Grove, 22 June 1991, ex *Pinus rigida,* 1 female; 11 Aug 1991, 3 females; Rt. 70 W Burrs Mill, 11 Aug 1991, ex *Pinus rigida,* 1 female. NEW YORK: Jefferson Co., Wellesley Island State Park, 16 Aug 1992, ex *Pinus rigida,* 1 female. PENNSYLVANIA: Clinton Co., Petes Run Rd., Sproul State Forest, 29 June 1991, ex *Pinus rigida,* 1 female; Schuylkill Co., Rt. 25 W Newtown, 2 June 1991, ex *Pinus rigida,* 1 female.

Derbidae

Nymphal derbids are thought to feed under bark on fungi while adults are found on the above ground parts of monocots, woody dicots, and, rarely, on ferns. About 60% of derbid species have been recorded from a single host suggesting a tendency toward monophagy (Wilson et al. 1994). *Apache degeerii* nymphs have been found beneath the bark of a living oak tree (Wilson 1982); adults have been collected on woody dicots in three plant families. Three species of *Otiocerus* have been taken on woody dicots in two plant families. *Otiocerus coquebertii* nymphs have been collected from under the bark of dead trees and adults have been recorded from woody dicots in two plant families (Wilson et al. 1994).

Apache degeerii (Kirby)

Distribution: Maine south to Florida and west to Minnesota and Texas; also recorded from British Columbia and Cuba (Metcalf 1945, Wilson and McPherson 1980, S.W.W., unpubl. data).

Pine Barrens records: MAINE: York Co., Killick Pond Barrens, 8 Aug 1990, ex *Quercus ilicifolia,* 2 males, 1 female; Waterboro Barrens, 7 Aug 1990, ex *Quercus ilicifolia,* 2 females. Oxford, Co., Fryeburg Barrens, 10 Aug 1990, ex *Quercus ilicifolia,* 1 male, 1 female. MASSACHUSETTS: Franklin Co., Montague Barrens, 4 Aug 1990, ex *Quercus ilicifolia,* 1 female. NEW YORK: Ulster Co., Mohonk Preserve, Overcliff Rd., 3 Aug 1990, ex *Quercus ilicifolia,* 1 male. Warren Co., Peggy Ann Rd., W Glens Falls, 3 Aug 1990, ex *Quercus ilicifolia,* 3 females. WEST VIRGINIA: Greenbrier Co., Kates Mtn., White Sulphur Springs, 25 Aug 1990, ex *Quercus ilicifolia,* 1 female.

Host plant records: *Quercus ilicifolia* (present study). *Quercus* sp., *Fagus* sp., *Acer* sp., *Carya* sp. (Swezey 1904).

Otiocerus coquebertii Kirby

Distribution: Nova Scotia south to North Carolina and west to Ontario, Minnesota, and Texas (Metcalf 1945, present study).

Pine Barrens records: MAINE: York Co., Killick Pond Barrens, 8 Aug 1990, ex *Quercus ilicifolia,* 1 female

Host plant records: *Quercus* sp., *Fagus* sp., *Acer* sp. (Van Duzee 1889).

Issidae

Nymphal and adult issine issids appear to be mainly polyphagous on the above ground parts of woody dicots with some feeding on gymnosperms (Wilson et al. 1994). No common pattern of host plant relationships is apparent for the North American species of *Thionia. Thionia bullata* (Say) has been recorded from *Pinus* spp., *T. elliptica* (Germar) from oaks (Fagaceae), *T. producta* Van Duzee from *Juniperus* (Cupressaceae), and *T. simplex* from numerous dicots (Wheeler and Wilson 1988, Wilson et al. 1994).

Thionia elliptica (Germar)

Distribution: Pennsylvania south to Virginia and North Carolina and west to Arkansas (Wheeler and Wilson 1987, present study).

Pine Barrens records: VIRGINIA: Augusta Co., Big Levels barren, 26 Aug 1990, ex *Quercus ilicifolia,* 4 females. For records from pine barrens in Pennsylvania, see Wheeler and Wilson (1987).

Host plant records: *Quercus ilicifolia, Q. marilandica* (Wilson et al. 1994).

Discussion

Even for the well-collected New Jersey Pine Barrens there are relatively few papers that specifically treat its insect fauna (Boyd and Marucci 1979). Great diversity, however, is known to characterize many insect families of this community, although species richness varies considerably among the groups (Boyd and Marucci 1979, Boyd 1991). Less is known about the insects of northeastern pitch pine-scrub oak barrens, though recent surveys of selected barrens have revealed a rich lepidopteran fauna (Schweitzer and Rawinski 1987, Widoff 1987). In addition, more than 40 plant bug

Table 1. Synopsis of collecting data on pine barrens planthoppers.

Taxon	*Quercus ilicifolia*	*Pinus rigida*	*Kalmia angustifolia*	Number of ♂	Number of ♀
Achilidae					
Catonia cinctifrons (Fitch)	●	●		4	1
Catonia picta Van Duzee		●		4	1
Catonia pumila Van Duzee		●		15	23
Epiptera brittoni Metcalf	●				1
Epiptera variegata (Van Duzee)		●		2	1
Synecdoche dimidiata (Van Duzee)	●			11	12
Synecdoche impunctata (Fitch)	●			8	15
Cixiidae					
Cixius pini Fitch		●		1	
Cixius quebecensis Beirne			●	1	2
Myndus wheeleri Wilson		●		10	9
Oliarus quinquelineatus (Say)		●		29	31
Derbidae					
Apache degeerii (Kirby)	●			5	9
Otiocerus coquebertii Kirby	●				1
Issidae					
Thionia ellpitica (Germar)	●				4

species are known from scrub oak in these barrens and related communities (Wheeler 1991). Our collecting in pine barrens has now shown that these communities are also inhabited by a diversity of Fulgoroidea.

A total of 154 adults of 13 planthopper species in four families was collected from pitch pine or scrub oak in pine barrens and related communities (Table 1), ranging from the northern limits of pitch pine-scrub oak barrens in Maine to a ridgetop barren in Virginia. Three specimens of an additional species, the cixiid *C. quebecensis,* were taken on sheep laurel. Of the 13 pine- and oak-associated planthoppers, only two, the achilids *C. cinctifrons* and *S. dimidiata,* were found on both pitch pine and scrub oak. Although none of the species are restricted to pine barrens, several were collected consistently in northeastern pitch pine-scrub oak barrens. Those that probably can be considered characteristic of this community type include the achilid *C. pumila* and the cixiid *O. quinquelineatus* on pitch pine, the achilid *S. impunctata* on scrub oak, and *S. dimidiata* on both plant species. The issid *T. elliptica,* recorded here only from scrub oak in a Virginia barren, should also be considered a characteristic pine barrens species (Wheeler and Wilson 1987).

Nearly all of the 14 planthopper species reported here are known to be widely distributed. The most notable range extension is that of *C. quebecensis* from the Shawangunk Mountains in southeastern New York. This cixiid, described as *C. fulvus* from Quebec and Prince Edward Island (Beirne 1950), has since been reported only from Maine (Kramer 1981). Another significant discovery during this survey was an undescribed species of the cixiid genus *Myndus.* Described herein as *M. wheeleri,* it was encountered only in the New Jersey Pine Barrens, where adults were sometimes common in old cones on pitch pine trees.

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TRIGONALYIDAE (HYMENOPTERA) IN THE EASTERN UNITED STATES: SEASONAL FLIGHT ACTIVITY, DISTRIBUTIONS, HOSTS

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Abstract.—Three of the four Nearctic species of Trigonalyidae occur in the eastern United States, *Orthogonalys pulchella* (Cresson), *Taeniogonalos gundlachii* (Cresson) (= *Poecilogonalos costalis* (Cresson)), and *Lycogaster pullata* Shuckard. Seasonal flight data is determined from collections of 4272 specimens from eight study sites in Maryland, Virginia, and West Virginia. *Orthogonalys pulchella* and *T. gundlachii* flights begin in mid-May and peak in June and the first of July, but both species are present in low numbers through the first of October. The flight period of *L. pullata* could not be determined. Identification, distributions, hosts, and habitats are reviewed for each species.

Key Words: Trigonalyidae, Trigonalidae, parasitoids, North America, seasonal activity, distributions, hosts

Trigonalyidae (= Trigonalidae) are parasitoids of ichneumonid and tachinid parasitoids of Lepidoptera and Diptera and parasitoids of social wasps. In Australia, they have been recorded as primary parasitoids of sawflies (Raff 1934, Carne 1969). Their life cycle is complex and precarious for survival. Thousands of eggs are deposited on leaves by each female. Further development is dependent not only on a caterpillar ingesting the eggs with the leaves but also dependent on an already parasitized caterpillar ingesting the eggs. The trigonalyid then develops on the parasitoid of the caterpillar. Trigonalyids do not develop if ingested by a non-parasitized caterpillar, though the trigonalyid immature may remain viable in case the caterpiller is later parasitized. For those that develop on wasps, a caterpillar that has ingested the eggs must be taken as prey by the wasp back to the larvae in its nest. A general account of the known biology of trigonalyids is given by Clausen (1931, 1940), with more recent and complete summaries by Weinstein and Austin (1991) and Carmean (1991).

There are four Nearctic species of Trigonalyidae. *Orthogonalys pulchella* (Cresson) and *Taeniogonalos gundlachii* (Cresson) occur in eastern North America; *Lycogaster pullata* Shuckard is transcontinental; and *Bareogonalos canadensis* (Harrington), a parasitoid of Vespidae, is western. I have collected all three eastern species during 13 years of trapping at eight sites in Virginia, Maryland, and West Virginia, though concentrated collecting has been done only from 1987 through 1994, and have accumulated seasonal flight information based on collections of 4272 specimens. This is probably one of the largest collections of this family, which was once considered very rare and was scarce in collections. Here, I give an identification guide to the three species, outline

their seasonal flight activity in the mid-Atlantic states, and review distribution, host, and habitat data.

Materials and Methods

Collections were by Townes-style Malaise traps (Townes 1972), using 95% ethyl alcohol as a killing agent. Dry collecting heads using cyanide were used only in Green Ridge State Park, Allegany Co., Maryland. Traps were in operation from the first of March or April through September to mid-November, depending on the site. They were serviced about every ten days to three weeks, depending on the weather and time of season. Collections were made from eight sites in Maryland, Virginia, and West Virginia from the coastal plain (Essex Co., Va.) to the Appalachians (Tucker Co., W. Va., and Allegany Co., Md.), from 1983 through 1994 (see specimens examined sections for localities and years of operation). One trap was used at the Fairfax Co., Virginia, site (back yard trap). Two traps were used at the Hardy Co., West Virginia, site. Four to 20 traps were used per year at each of the other sites, the number differing from year to year at some sites. The traps were placed in different habitats on the sites which ranged from less than 100 to more than 600 acres in size. Sawflies (Symphyta) were the target groups for my collections; consequently, most traps were placed in situations where I would expect to obtain the largest numbers and greatest diversity of these groups. Good sawfly habitats also proved productive for Trigonalyidae.

Townes' (1956) revision of the Nearctic species is still useful. No additional species have been found. References to original descriptions and synonyms may be found in Townes (1956) and Carlson (1979). A current classification of the world Trigonalyidae by Carmean and Kimsey is in press.

Specimens used in this study are deposited in the National Museum of Natural History, Washington, D.C.

Identification

The four Nearctic species were separated by Townes (1956) by morphological characters. However, the eastern species are readily separated by color and habitus. The following simplified key and the accompanying illustrations will separate them.

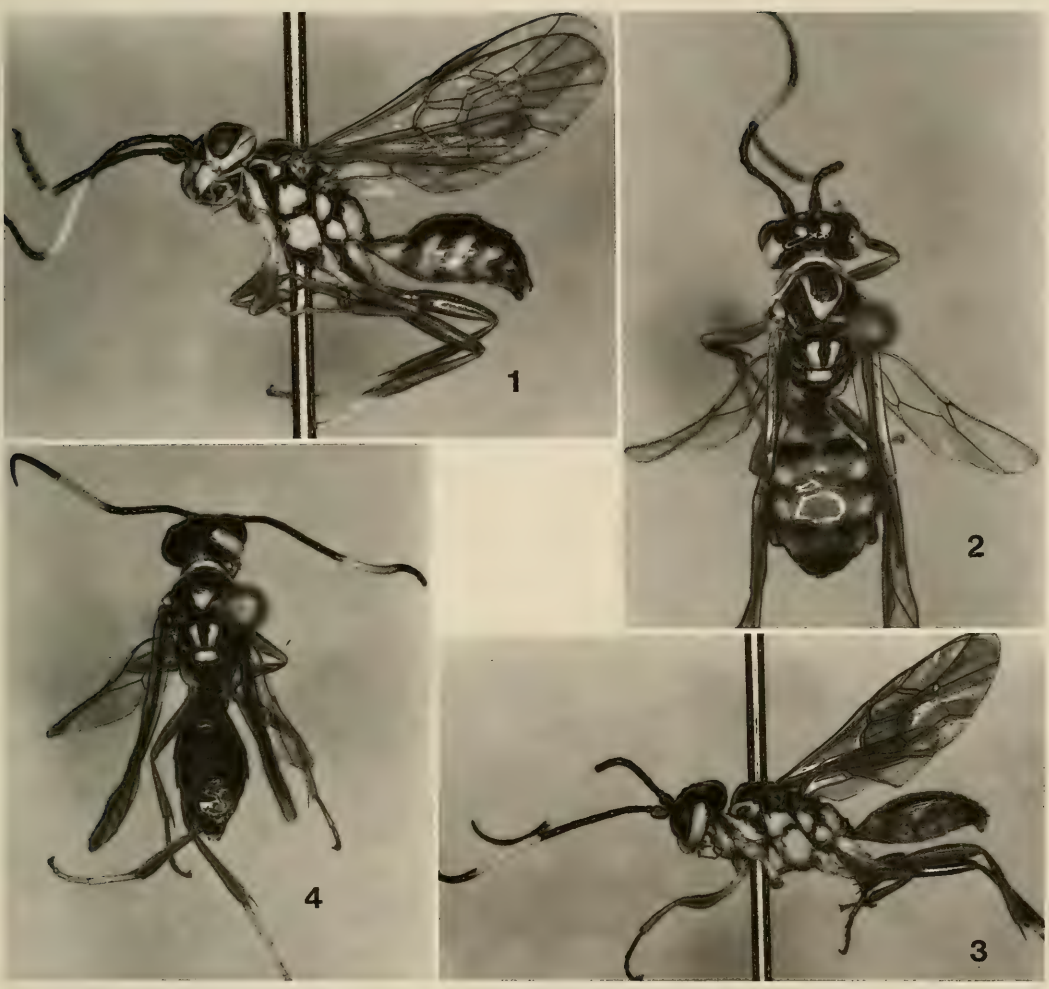
1. Antenna with a white band; black with considerable yellowish to orange markings; ichneumonid-like in appearance (Figs. 1–4) . . . . . *Orthogonalys pulchella* (Cresson)
– Antenna black; black or mostly black with yellow marks; wasp-like in appearance (Figs. 5–12) 2
2. Black, with several transverse yellow lines on abdominal terga only; antenna thickened (Figs. 9–12); forewing uniformly hyaline to slightly darkened . . . . . *Lycogaster pullata* Shuckard
– Black with yellow marks behind eyes, on mesopleuron, mesoprescutum, mesoscutellum, and solid transverse stripes on abdomen; antenna slender (Figs. 5–8); dorsoapical portion of forewing infuscated . . . . . *Taeniogonalos gundlachii* (Cresson)

Orthogonalys pulchella (Cresson) (Figs. 1–4, 13–15)

This is by far the most common trigonalyid in eastern North America. Specimens were common at most of my collecting sites. The size is extremely variable, ranging from about 5 to 12 mm in length.

Distribution.—Connecticut, District of Columbia, Maine, Maryland, New Jersey, New York, Pennsylvania, Rhode Island, Virginia, West Virginia.

Specimens examined.—Total: 3827. MARYLAND: Allegany Co., Green Ridge State Park (61; 1992–1993); Prince Georges Co., Beltsville Agricultural Research Center (291; 1991–1993). VIRGINIA: Clarke Co., University of Virginia Blandy Experimental Farm, 2 mi. S. Boyce (1947; 1990–1994); Essex Co., 1 mi. SE Dunnsville (729; 1991–1994); Fairfax Co., near Annandale (20; 1983–1994); Louisa Co., 4 mi S. Cuckoo (704; 1987–1989). WEST VIRGINIA: Hardy Co., 3 mi. NE Mathias (22; 1994); Tucker Co., Fernow Experimental Forest, 3 mi S. Parsons (26; 1991–1993).



Figs. 1–4. *Orthogonalys pulchella.* 1, Female, lateral. 2, Female, dorsal. 3, Male, lateral. 4, Male, dorsal. Length, ca. 9 mm.

Hosts.—Known only from tachinid parasitoids of Lepidoptera caterpillars: *Archytas aterrimus* (Robineau-Desvoidy) (Tachinidae) (Carlson, 1979). Records citing parasitism of *Nilea lobeliae* (Tachinidae) in *Acronicta lobeliae* are incorrect (Carmean and Kimsey, in press) (see *T. gundlachii*). A specimen from Connecticut is labeled "ex *Ellopia athasaria*" (Geometridae).

Flight records.—Townes (1956) reported that males occur mostly in June and early July with extreme dates of May 25 and July 21, and that females occur mostly from mid-June to mid-August, with extreme dates of June 7 and August 23.

I collected this species from the middle third of May through the first part of October (Figs. 13–15). The peak flight is in June, with the greatest number of specimens during the middle third of June. The species is present in low numbers through the rest of the season, but there is a low peak during the last third of August through the first third of September. The climb to the peak flight in June and the decline after June are very abrupt. The peak flight in Essex Co., the most southern site, is the first third of June (Fig. 13), whereas the peak flight at more northern localities is mid-June, as at the Clarke Co. site (Fig. 14). It

is very numerous during the peak flight time in June. As many as 92 specimens were taken in one trap in Clarke Co., June 8–18, 1991, and 114 specimens June 15–24, 1994, and 123 specimens were in a single trap in Louisa Co., June 8–18, 1988.

Habitats.—Townes (1956) reported that this species is most common in damp, rich woodlands where they occur on the foliage at about the 35-cm level. They crawl over the foliage or take short flights. In size, coloration, and movements, they mimic several species of ichneumonids and sawflies that are common in the same habitats.

I have caught specimens in almost every habitat where I have set traps, but they are by far most common within woodlands and damp, bottomland woods. At the Beltsville Agricultural Research Center, where traps were set in four different habitats, most (274 of the 291 specimens) were collected in a bottomland deciduous forest trap. In Clarke Co., most were collected within a 40 acre, 90-year-old, oak-elm-hickory woodlot in traps set at the forest edge and within the forest. In 1994, four traps were used in the woodlot and four nearly a mile away in open shrubby areas around ponds and near fields. Of the 498 specimens collected, 482 were in the woodlot. At Green Ridge State Park, most specimens (53) were collected in two traps located in a bottomland forest near a stream with very few (8) in four traps set in openings or semi-openings on an adjacent shale barren ridge. In Hardy Co., West Virginia, all 22 specimens were from a trap by a stream in the woods; none were in a trap in a clearing on a ridge about 100 yards away.

Taeniogonalos gundlachii (Cresson)
(Figs. 5–8, 16)

This is the second most commonly collected species of Trigonalyidae. It was most common at my most southern collecting site (Essex Co.). None were taken at the most western sites in western Maryland and Tucker Co., West Virginia. Specimens ranged from 5 mm to 11 mm in length. Most literature references to this species are under the name *Poecilogonalos costalis* (Cresson). Carmean and Kimsey (in press) dealt with the taxonomy of this species, and all changes and synonymies should be attributed to them.

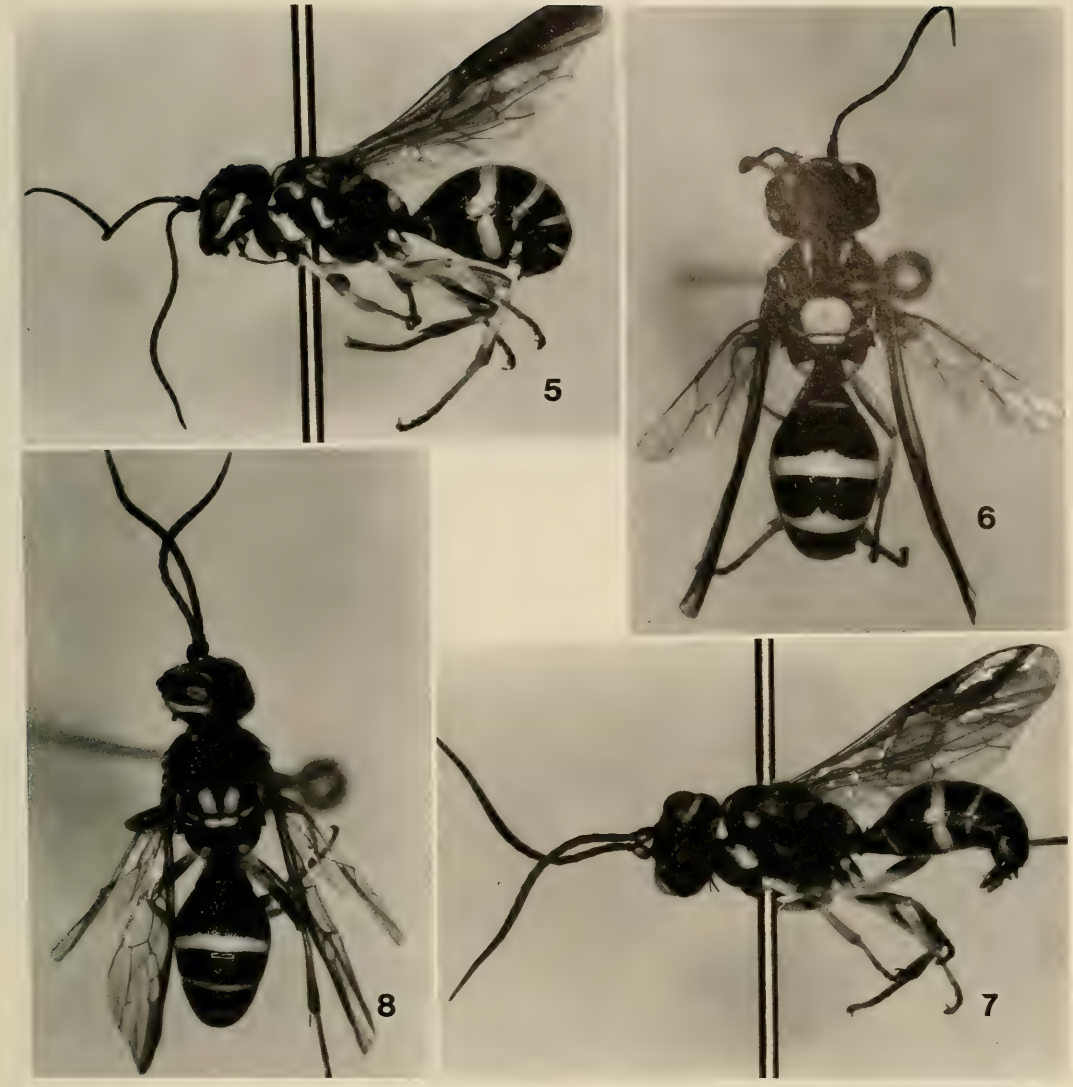
Distribution.—Connecticut, Florida, Kansas, Louisiana, Maryland, Massachusetts, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Texas, Virginia, West Virginia; Cuba.

Specimens examined.—Total: 440. MARYLAND: Prince George's Co., Beltsville Agricultural Research Center (46; 1991–1993). VIRGINIA: Clarke Co., University of Virginia Blandy Experimental Farm, 2 mi. S. Boyce (29; 1990–1994); Essex Co., 1 mi. SE Dunnsville (252; 1991–1994); Fairfax Co., near Annandale (11; 1983–1994); Louisa Co., 4 mi. S. Cuckoo (99; 1987–1989). WEST VIRGINIA: Hardy Co., 3 mi. NE Mathias (3; 1994).

Hosts.—Known only from tachinid parasitoids of Lepidoptera caterpillars and one record from a tipulid larva: *Lespesia* sp. (Tachinidae) ex *Phosphila turbulenta* Huebner (Noctuidae); reared as a secondary parasitoid of *Automeris io* (F.) (Saturniidae) (Carlson 1979); from *Nilea lobeliae* (Coquillett) (Tachinidae) parasitizing *Acronicta lobeliae* Guenée (Noctuidae) (Riley and Howard 1891); reared from a puparium of *Allophorocera arator* (Aldrich) (Tachinidae) which parasitized a larva of *Tipula* (*Triplicitipula*) sp., probably *flavoumbrosa* Alexander (Tipulidae) (Gelhaus 1987). Labels on specimens I have examined are as follows: "ex *Symmerista albifrons* [Notodontidae]" (from Connecticut); ex *Hadena turbulenta* [Noctuidae]" (from Massachusetts); "ex larva on *Quercus,* host: *Anisota discolor* [Saturniidae]" (from Texas); and "ex *Macrurocampa marthesia* [Notodontidae] on oak" (from West Virginia).

Flight records.—Townes (1956) reported that most collection dates were from June 25 through August 4, with extreme dates of June 10 and September 6.

I have collected this species from mid-May through the first week in October (Fig.



Figs. 5–8. *Taeniogonalos gundlachii.* 5, Female, lateral. 6, Female, dorsal. 7, Male, lateral. 8, Male, dorsal. Length, ca. 9 mm.

16). The peak flight is from mid-June through the first third of July, slightly later than the peak flight of *O. pulchella.* However, similar to *O. pulchella,* they are present in low numbers through the rest of the season into October, and there is a very low peak from the end of August through the first third of September. Collection records show a gradual increase in numbers from the last of May to the peak during the first third of July, unlike the more abrupt rise of *O. pulchella.* Of the 440 specimens, 341 were collected from the middle third of June through the middle third of July.

Habitats.—Townes (1956) reported this species in partially sunlit openings of rich woods with abundant undergrowth, at the 20- to 40-cm level. I have collected specimens in most traps from various habitats. It is not collected in large number like *O. pulchella,* and the species appears to be more generally distributed than *O. pulchella.* At the Beltsville

Figs. 9–12. *Lycogaster pullata.* 9, Female, lateral. 10, Female, dorsal. 11, Male, lateral. 12, Male, dorsal. Length, ca. 10 mm.

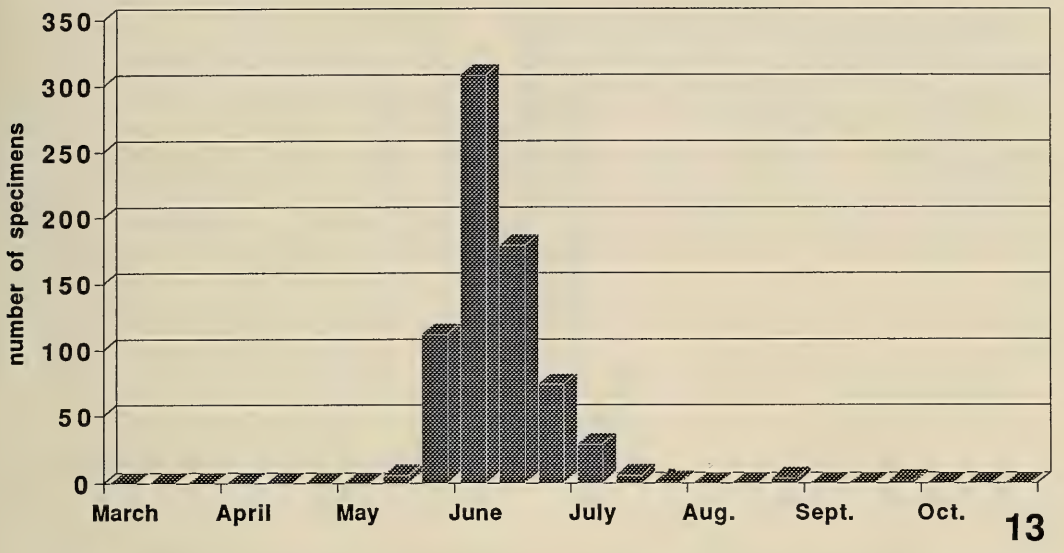
Agricultural Research Center as many or more specimens were in open or semi-open traps (34 in 3 traps) as in those in more shaded woodlands (12 in 1 trap in a bottomland deciduous forest). The same is true for collections in Clarke and Essex counties.

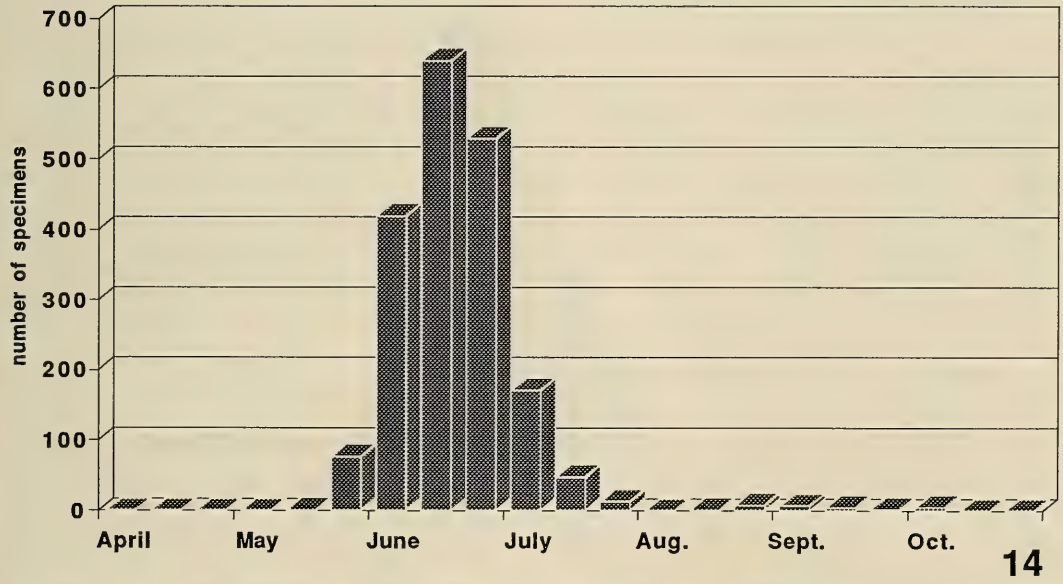
Lycogaster pullata Shuckard
(Figs. 9–12)

I collected only 5 specimens of this species. The species is sometimes divided into eastern and western subspecies, *L. pullata pullata* in the East and *L. pullata nevadensis* (Cresson) from Colorado and New Mexico westward.

Distribution.—In eastern United States: District of Columbia, Georgia, Maryland, Massachusetts, Michigan, Minnesota, New York, North Carolina, North Dakota, Pennsylvania, Rhode Island, Vermont, Virginia.

Specimens examined.—Total: 5. MARYLAND: Allegany Co., Green Ridge State



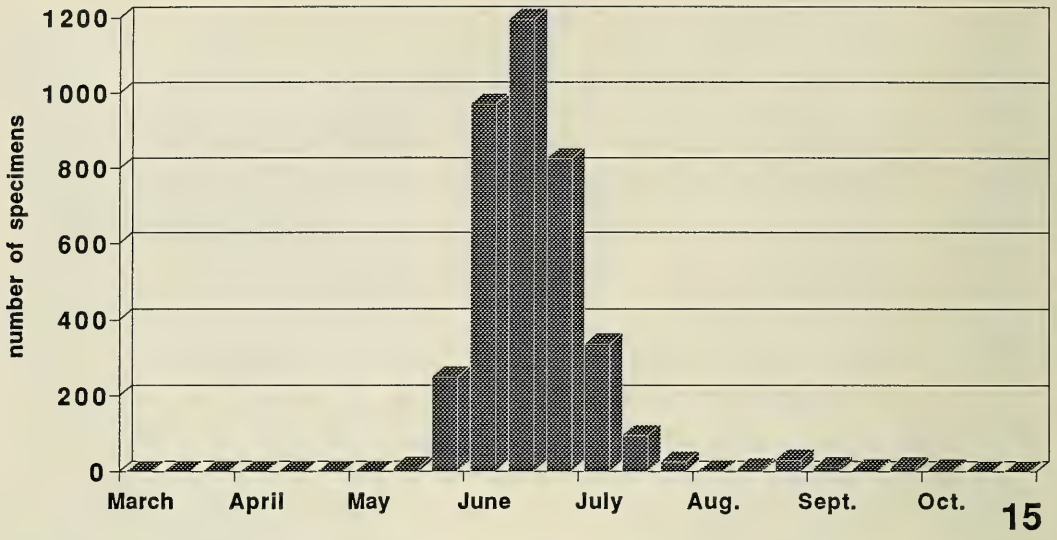


Figs. 13, 14. Flight records of *Orthogonalys pulchella.* 13, Essex Co., Virginia, 1991–1994. Traps in operation from the first of March through October. 14, Clarke Co. Virginia, 1990–1994. Traps in operation from the first of April through October.

Park (2; 1992–1993). VIRGINIA: Essex Co., 1 mi. SE Dunnsville (3; 1991–1994).

Hosts.—Known from caterpillar-provisioning eumenine wasps and from ichneumonid parasitoids of caterpillars: *Euodynerus foraminiatus foraminiatus* (Saussure) (Eumenidae) (Cooper, 1954); *Enicospilus americanus* (Christ) (Ichneumonidae) ex *Antheraea polyphemus* (Cram.) (Saturniidae) (Bischoff 1909, Townes 1956). From *Hyphantria cunea* (Drury) (Arctiidae) in Colorado (Townes 1956).

Flight records.—Townes (1956) reported dates of collection in June and July with extreme dates of May 9 and August 25. Collection dates in Essex Co. are May 25



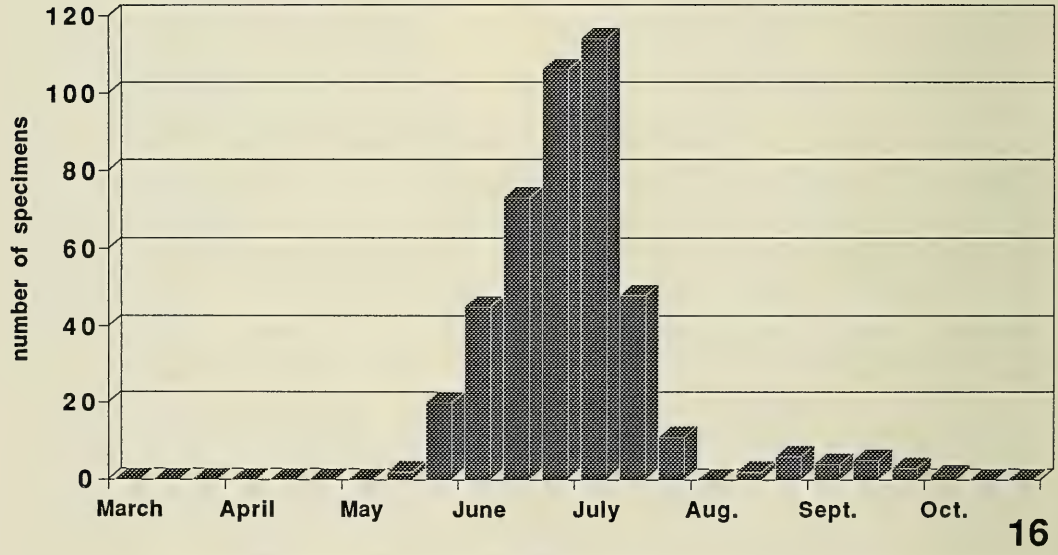


Fig. 15, 16. Cumulative flight records for all site collections, 1983–1994. 15, *Orthogonalys pulchella.* 16, *Taeniogonalos gundlachii.*

to June 5, 1991 (2) and September 23 to October 9, 1993(1), and in Allegany Co., June 10 to 20, 1992 (1) and July 20 to 29, 1992 (1).

Habitats.—Townes (1956) stated that this species occurs in more open and dry habitats than the other species. My two collection records come from traps set in dry, open situations. All specimens from Essex Co. were from one trap located in the open near a forest edge in direct sunlight most of the day. The soil is sandy in the area. The collections from Green Ridge were from traps located in openings on a shale barren where it is typically drier and warmer than the surroundings.

Association of Trigonalyidae with Sawflies

Sawflies have not been recorded as hosts in North America. However, large numbers of Trigonalyidae were collected in areas

where sawflies were also common, especially species of the sawfly genera *Taxonus, Ametastegia,* and *Macrophya* (Tenthredinidae). Most species of *Macrophya* have peak flights in June (Smith 1991, recorded seasonal flights for 28 species in Virginia), and several common species of *Taxonus* have peak flights in May to July as well as another smaller emergence peak in late August to mid-September (similar to Figs. 15 and 16). *Macrophya* are associated with several hosts, including *Sambucus* and *Prunus,* but hosts are unknown for many species. Most *Taxonus* are associated with *Rubus* and *Fragaria,* and *Ametastegia* with Polygonaceae. Many of the sawflies have not been intensively studied or reared, and their parasitoids are yet to be recorded. Even though there are many other phytophagous insects in the habitats, the similar flight times of trigonalyids and many sawflies, their presence in similar habitats, and the possibility that trigonalyid eggs remain viable for months on foliage (Clausen 1931) and are available when sawfly larvae develop, indicate that sawflies may serve as intermediate hosts.

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AN UNUSUAL OCCURRENCE IN WEST VIRGINIA OF STONEFLIES (PLECOPTERA) IN THE PITCHER-PLANT, *SARRACENIA PURPUREA* L. (SARRACENIACEAE)

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Abstract.—Two species of stoneflies, *Leuctra duplicata* Classen and *Leuctra maria* Hanson, were recovered from a population of the American pitcher plant (*Sarracenia purpurea* L.) collected from Big Run Bog, Tucker County, West Virginia. Eight specimens—5 adults, 2 nymphs and 1 exuvium—were recovered from 99 leaves collected in May, 1994. This is the first report of Plecoptera in pitcher plants. This is also the first report of *Leuctra maria* in West Virginia; previous studies indicated it to have a more northern distribution.

Key Words: Plecoptera, stonefly, *Sarracenia,* pitcher plant, aquatic insect, bog, *Leuctra*

Although vegetation of large *Sphagnum*-dominated bogs has been studied extensively in both North America and Europe, limited information exists on plant and animal communities of small *Sphagnum* bogs associated with mountain headwater streams (Damman 1979). Bogs can contain many unusual plant species such as the American pitcher plant, *Sarracenia purpurea* L. This widely distributed species is of interest because it exhibits passive carnivory.

A number of reports document that *S. purpurea* plants trap a diverse variety of insects and other arthropods (Rymal and Folkerts 1982, Bradshaw and Creelman 1984). Nectar guides, in the form of red-purple veins, lead up the brightly colored pitcher-shaped leaves (Joel 1986). These attract insects to the lip where some inadvertently fall into and drown in the water which collects at the base of the leaves and provides nutrition for the plant (Meir et al. 1991). *Sarracenia purpurea* relies on a rich community of bacteria, protozoa and insect larvae for decomposition of trapped prey, enabling absorption of nutrients by the plant (Addicott 1974).

While studying a population of *S. purpurea* in West Virginia, we dissected several leaves and emptied the contents into a petri dish to observe living and dead trapped insects. Because one of the leaves contained an alive adult stonefly (*Leuctra* sp.), an unusual occurrence, we undertook a study to investigate how common stoneflies were to this population of pitcher-plants. Stoneflies were also collected from a nearby stream—a more recognized habitat for them.

Materials and Methods

Location.—The *S. purpurea* population is located in Big Run Bog (also known as

Table 1. Stoneflies (*Leuctra*) specimens recovered from pitcher-plant (*Sarracenia purpurea*) leaves, May, 1994 (M = male, F = female).

Species	Nymphs	Adults	Exuvium
Leuctra duplicata Claassen		2 M: 1 F	
Leuctra maria Hanson	2 mature F	1 M: 1 F	
Leuctra sp.			1
TOTAL	2 mature F	3 M: 2F	1

Olson Bog) located at 39°07″N latitude and 79°35′W longitude, Tucker County, West Virginia. The bog is at an elevation of 980 m above sea level and occupies approximately 20–25 ha in the Monongahela National Forest (Wieder et al. 1981). Big Run Bog is dominated by *Sphagnum* and *Polytrichum* which together cover 85% of the surface (Wieder et al. 1981). *Sarracenia purpurea* was introduced to this bog in 1946 (Strausbaugh and Core 1970) and is well established today.

Methods.—Four mature plants were collected on May 18, 1994, for leaf analysis. Plants were scooped up by hand, placed in plastic pans with water, covered and transported back to the laboratory at Blackwater Falls State Park, West Virginia. Three additional plants were collected for leaf analysis on June 14–15, 1994.

Individual leaves were examined after being removed from the main cluster by cutting at the base with a razor blade and pouring the liquid contents into a petri dish. An accession number was assigned to each leaf and recorded. The leaf was then slit with a razor blade lengthwise, folded open and the solid contents at the base of the leaf were removed with a spatula and placed in 70% ethanol. Live Diptera larvae remaining on the leaves as well as those in the liquid contents were removed with forceps and placed in the alcohol and labelled. Ninety-nine leaves were analyzed from the May collections and forty-seven leaves from the June collections.

Once all the samples were collected, the dead stonefly specimens were removed from samples and placed in separate vials for later identification.

Approximately 200 meters from the pitcher plant site, a small stream ran into the bog. During both May and June, adult stonefly specimens in the vicinity of the stream were collected by net and by using a beating sheet.

Results and Discussion

Two species of stoneflies, *Leuctra duplicata* Claassen, and *Leuctra maria* Hanson, were recovered from the leaf samples (Table 1). All were from samples collected in May. A total of 8 stonefly specimens were found including 2 nymphs, 5 adults and 1 exuvium. One leaf contained one *L. maria* adult and one *Leuctra* sp. exuvium. Although 47 leaves were inspected in June, no Plecoptera were recovered.

Leuctra maria has not previously been reported in West Virginia. It is reported to have a more northern distribution (Stark et al. 1986). This uncommon species is poorly represented in collections.

More species of Plecoptera were found in the hand-collected material than were recovered from the *S. purpurea* leaves (Table 2). The stream samples contained 7 species: one from the family Nemouridae, namely, *Ostrocerca albidipennis* (Walker), and six species of *Leuctra* from the family Leuctridae.

The occurrence of two species of Plecoptera, and in particular, *Leuctra maria,* in pitcher-plants is unexpected. Although a variety of insects have been associated with *S. purpurea* (Bradshaw and Creelman

Table 2. Adult stoneflies (Plecoptera) collected by net and beating sheet near the *Sarracenia purpurea* site (M = male, F = female).

Family/Species	May 17–18	June 14–15
Nemouridae		
Ostrocerca albidipennis (Walker)	4 M: 18 F	1 F
Leuctridae		
Leuctra biloba Claassen	12 M: 16 F	1 M
Leuctra duplicata Claassen	13 M: 16 F	79 M: 63 F
Leuctra ferruginea (Walker)		18 M: 35 F
Leuctra maria Hanson	16 M: 17 F	35 M: 17 F
Leuctra sibleyi Claassen	16 M: 15 F	
Leuctra triloba Claassen		14 M: 18 F

1984), this is the first report of a stonefly species.

Stoneflies are generally associated with running water, not bogs. While it is possible that the adults were trapped after being blown by the wind to the pitcher-plant site or by flying or walking there, the presence of mature nymphs in the leaves is puzzling. One explanation is that these species live in the waters of the bog where they complete their life cycles. A more likely possibility is that these species spend much of their life cycle in the nearby stream. During spring, however, when the water level in the bog is high from snow melt and rain, some nymphs could disperse throughout the bog. In the process of emerging, the mature nymphs may climb out of the water onto the pitcher-plant leaves, with a few becoming trapped in the plants.

Acknowledgments

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CHECKLIST OF THE PSYLLIDS (HOMOPTERA: PSYLLOIDEA) OF MEXICO

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Abstract.—The checklist of Mexican Psylloidea includes 119 species in 39 genera and six families. Within the Psyllidae, there are 59 species in 27 genera; in the Triozidae, 51 species in seven genera; in the Carsidaridae, five species in two genera; in the Homotomidae, two species in one genus; and in each of the Phacopteronidae and the Calophyidae, there is one species. Fifty-four species of psyllids are known only from Mexico.

Key Words: Check list, jumping plant lice, Psylloidea, systematics

The psyllids, or Psylloidea, are a group of small sap-sucking insects that are superficially similar in appearance to miniature cicadas. The group is comprised of about 2000 species (Brown and Hodkinson 1988) that feed primarily on woody dicotyledenous plants. Until relatively recently, the literature in the New World treated the group as a single family with several subfamilies, but it is now generally agreed that the psyllids should be treated as a superfamily with six or seven families.

Research on the systematics of the psyllids of Mexico has been undertaken primarily by a small number of American and European entomologists including D. L. Crawford, L. D. Tuthill, D. Burckhardt, D. Hollis, I. D. Hodkinson, S. B. Muddiman, and R. G. Brown. The information for this paper was compiled primarily from the checklists of Hodkinson and White (1981) and Hodkinson (1988), and secondarily from the papers of Muddiman et al. (1992), Brown and Hodkinson (1988), Burkhardt and Lauterer (1989), and Hodkinson (1990, 1991a, b, c). The objective of this paper is to compile the names of the psyllid species recorded from Mexico as a baseline of knowledge for studies of Mexican psyllid biodiversity. In many instances records have been published that are not an obvious source of Mexican data; this publication compiles these data so that they are readily available. The checklist provides the valid name for each taxon known to occur in Mexico and a primary reference for each record. An asterisk behind the name indicates that the species is known only from Mexico. Species are listed in alphabetical order within each genus, followed by the author of the species, and a number that corresponds with a reference in the terminal bibliography.

Results

The described psyllid fauna of Mexico includes 119 species in 39 genera and six families. The family Psyllidae contains 59 species in 27 genera; the Triozidae, 51 species in seven genera; the Carsidaridae, five species in two genera; the Homotomidae, two species in one genus; and each of the

Calophyidae and Phacopteronidae contains one species.

Psyllidae

Acizzia
uncatoides (Ferris and Klyver), 3, 7
Ameroscena
mexicana Burkhardt and Lauterer, 2 *
Aphalara
simila Caldwell, 8
Aphalaroida
inermis Crawford, 8
lysilomae Hodkinson, 6
pithecolobia Crawford, 6
rauca Hodkinson, 6
Arytaina
virgina Caldwell, 8 *
Blastopsylla
occidentalis Taylor, 7
Burkhardtia
montana Brown and Hodkinson, 3a
Cacopsylla
americana (Crawford), 3
nana (Tuthill), 3
Caradocia
delongi Caldwell, 1
Craspedolepta
caudata (Crawford), 8
numerica (Caldwell), 8
nupera (Van Duzee), 8 *
veaziei (Patch), 8
Euceropsylla
minuticona (Crawford), 8
orizabensis (Crawford), 1
Euphalerus
fasciatus Laing, 8 *
gallicolus Ferris, 8 *
nidifex Schwarz, 8
Freysuila
dugesii Aleman, 8, 10 *
Haplaphalara
tuxtlaensis (Conconi), 1, 8 *
Heteropsylla
aurantiaca Muddiman, Hodkinson, and Hollis, 9
boquetensis Brown and Hodkinson, 9
clavata Muddiman, Hodkinson, and Hollis, 9 *
crawfordi Enderlein, 9
cubana Crawford, 9
didubiata Caldwell, 9 *
flexuosa Muddiman, Hodkinson, and Hollis, 9
forcipata Crawford, 9 *
fusca Crawford, 9
huasachae Caldwell, 9
intermedia Muddiman, Hodkinson, and Hollis, 9 *
mexicana (Crawford), 9 *
mimosae Crawford, 9
muricata Muddiman, Hodkinson, and Hollis, 9 *
nebulosa Muddiman, Hodkinson, and Hollis, 9 *
propinqua Muddiman, Hodkinson, and Hollis, 9
texana Crawford, 9
Katacephala
arcuata Crawford, 5, 8 *
cinctata Hodkinson, 5 *
grandiceps Crawford, 5
Limbopsylla
laguncularíae Brown and Hodkinson, 1
Livia
mexicana Caldwell, 8 *
Mitrapsylla
albalineata Crawford, 8
cubana Crawford, 1
deserata Caldwell, 8
Neophyllura
mexicana Jensen, 8 *
Pachypsylla
tropicala Caldwell, 8 *
Platycorypha
amabilis Caldwell, 8 *
magnifrons (Crawford), 1
princeps Tuthill, 8
Psylla
minutiforma Caldwell, 8 * (should be placed in a different genus)
Psyllopsis
mexicana Caldwell, 8 *
Rhinopsylla
antennata (Crawford), 8
Syncoptozus
mexicanus Hodkinson, 4 *
Tetragonocephala
flava Crawford, 8

Triozidae

Ceropsylla
discrepans Tuthill, 8 *
pulchra Tuthill, 8 *
sideroxyli Riley, 8
Kuwayama
elongagena (Caldwell), 8 *
hyalina Caldwell, 8 *
lateralis Caldwell, 8 *
medicaginis (Crawford), 8
mexicana Caldwell, 8 *
oaxacensis (Crawford), 8 *
striata Caldwell, 8 *
Leuronota
inusitata (Tuthill), 1
maculata (Crawford), 8
michoacana Ferris, 8 *
Paratrioza
cockerelli (Sulc), 8
dubia Tuthill, 8
plummeri Caldwell, 8 *
Trichochermes
magna (Laing), 1
Trioza
albifrons Crawford, 8
anceps Tuthill, 8 *
apartata Caldwell, 8 *
arizonae Aulman, 8
bella Tuthill, 8 *
bifurca Tuthill, 8 *
collaris Crawford, 8
dampfi Tuthill, 8 *
diospyri (Ashmead), 8
epiphitatae Caldwell, 8 *
grandipennis Tuthill, 8 *
hidalgoensis Caldwell, 8 *
incidata Tuthill, 8 *
inusitata Tuthill, 8
longigenae Tuthill, 1
magnoliae (Ashmead), 8
maritima Tuthill, 8 *
mexicana Crawford, 8
minor Tuthill, 1
nigriconus Tuthill, 1
nigriscutum Tuthill, 8 *
proximata Crawford, 8
psyllihabitus Tuthill, 1
rhinosa Caldwell, 8 *
rubra Tuthill, 8
rugosata Caldwell, 8 *
russellae Tuthill, 1
stroma Caldwell, 8 *
thoracica Caldwell, 8 *
zogoda Caldwell, 8 *
Triozoida
formiciformis (Caldwell), 1, 8 *
johnsonii Crawford, 8
limbata (Enderlein), 1
prima (Tuthill), 8

Calophyidae

Calophya
dicksoni Jensen, 8 *

Carsidaridae

Mastigimas
ernestii (Schwarz), 7, 10
schwarzi (Tuthill), 8
Paracarsidara
dugesii (Loew), 8
gigantea (Crawford), 8
mexicana (Crawford), 8 *

Homotomidae

Synoza
floccosa Ferris, 8 *
pulchra Laing, 8

Phacopteronidae

Epicarsa
corniculata Crawford, 1

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COURTSHIP BEHAVIOR, REPRODUCTIVE RELATIONSHIPS, AND ALLOZYME PATTERNS OF THREE NORTH AMERICAN POPULATIONS OF *ERETMOCERUS* NR. *CALIFORNICUS* (HYMENOPTERA: APHELINIDAE) PARASITIZING THE WHITEFLY *BEMISIA* SP., *TABACI* COMPLEX (HOMOPTERA: ALEYRODIDAE)

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Abstract.—Throughout the southern U.S., the serious whitefly pest, *Bemisia* sp. is parasitized by morphologically similar aphelinid parasitoids that have all been called *Eretmocerus* nr. *californicus*. In this study, the courtship behavior, reproductive compatibility, and allozyme patterns of three populations of *E.* nr. *californicus* from Texas, Arizona, and California were investigated to determine their species status. The courtship behavior of the three populations did not differ in the kinds of behaviors performed; the sequence of behaviors, or the frequency or duration of behaviors. Reciprocal mating trials between *E.* nr. *californicus* from Texas and *E.* nr. *californicus* from Arizona or California did not result in any successful mating, but there was no significant difference between the frequency of between- and within- population matings in the Arizona and California populations. Isoelectric focusing electrophoresis for the 3–5 allozyme loci scored for each population showed divergence of the Texas population from the populations from Arizona and California. The allele frequencies at the IDH locus differed between the Texas and the Arizona and California populations. Similarly, allele frequencies at the ME locus differed between the Texas and the Arizona populations. The Texas population showed two unique alleles at the MDH locus, but otherwise MDH, PGI, and PGM showed similar allele frequencies in all populations. The results of the mating trials and electrophoretic study corroborate subtle morphological and pigment differences between the Texas population and Arizona and California populations, and it is concluded that these populations represent two species.

Key Words: Systematics, electrophoresis, biological control, sweetpotato whitefly, silverleaf whitefly

Systematists involved in biological control projects may be confronted with an array of morphologically similar natural enemies from different geographical sources. Accurately delineating species is of critical practical importance; classifying a group of similar populations as the same species when they are not may obscure life history differences, and prevent effective natural enemies from being introduced to a new habitat (Rosen and DeBach 1973, Rosen 1986). Sibling species may differ in such

important characteristics as their host or habitat affinities (Rosen 1986, Wharton et al. 1990). Conversely, making spurious distinctions among conspecifics may result in unnecessary introductions and confusion in evaluating biological control efforts (Rosen 1986). Biosystematic studies of reproductive relationships among populations may add to our understanding of species limits within a particular group, and more generally, to our knowledge of how variation in different character systems such as morphology, life history, behavior, and biochemical or genetic markers are correlated.

Widespread and damaging outbreaks of a whitefly, *Bemisia* sp., in many cropping systems of the Southern United States from 1986-1991 prompted a national research effort. Originally called the "B strain" of *Bemisia tabaci* (Gennadius), the whitefly has recently been given species status, and has been named *Bemisia argentifolii* Bellows and Perring, the silverleaf whitefly (Bellows et al. 1994). Controversy over the identity of this whitefly remains, however (see e.g. Bartlett and Gawell 1993, Campbell et al. 1993, Brown et al. 1995), therefore we will refer to it as *Bemisia* sp., *tabaci* complex.

Surveys of natural enemy species of this whitefly species have demonstrated that many if not all of the endemic natural enemies recorded from the sweetpotato whitefly attack the silverleaf whitefly (Gerling 1966, Coudriet et al. 1986, Polaszek et al. 1992, McAuslane et al. 1994). In all of these surveys, parasitoids in the genus *Eretmocerus* have been found, as well as one or more species of *Encarsia.* In southern California and Arizona, *Eretmocerus* dominates the parasitoid complex, and the *Eretmocerus* species in Texas is dominant at some times of the year (M. Rose, J. Woolley, and C. Moomaw, in litt.). In Florida as well, *Eretmocerus* may sometimes dominate (L. Osborne, pers. comm.). The identities of these *Eretmocerus* populations have been unclear. They have all been called *Eretmocerus* nr. *californicus,* but subtle morphological differences separate them from *Eretmocerus californicus* Howard (1895) (M. Rose and G. Zolnerowich, in litt.), originally described from an unknown whitefly on *Quercus agrifolia.* Small differences in sculpturing, antennal configuration, wing shape and setation of the females, and pigmentation of the males, differentiate wasps collected from Arizona and California from those from Texas, and the apparently mixed Florida population from either of these two groups (M. Rose and G. Zolnerowich, in litt.).

In order to interpret the biological meaning of these small morphological differences, we studied the reproductive relationships and allozyme patterns among three populations of *Eretmocerus* collected from *Bemisia* sp. in Arizona, California and Texas. We were also interested in evaluating the courtship behavior of these populations for the presence of distinguishing behavioral characters, and in a broader context, to compare courtship in this genus with courtship described for other aphelinid genera such as *Aphytis* (Gordh and DeBach 1978), and *Encarsia* (Viggiani and Battaglia 1983, Kajita 1989).

Currently, indigenous and exotic species of *Eretmocerus* are being evaluated and colonized for biological control of *Bemisia* sp. in the U.S. In addition, the *Eretmocerus* sp. collected from *Bemisia* sp. in Texas has been reared and released in California (C. Pickett, pers. comm.). Another objective of this study was to determine the likelihood of these populations hybridizing when sympatric, and to develop character systems which could be used in addition to morphological characters to aid in distinguishing the naturally occurring populations of *Eretmocerus.*

Materials and Methods

Collection information.—Three *Eretmocerus* populations were sampled in this study. In Weslaco, Texas, cabbage leaves bearing parasitized *Bemisia* were collected on June 10, 1993. Melon leaves bearing

parasitized *Bemisia* were collected in Bard, California on June 7, 1993, and poinsettia leaves bearing parasitized *Bemisia* were collected in a greenhouse in Tucson, Arizona on June 11, 1993. The greenhouse supported a large continuous culture of an *Eretmocerus* that was originally collected from *Bemisia* in Phoenix, Arizona (O. Minkenberg, pers. comm.). All of the leaves were sent to College Station, where approximately 300–400 pupae from each collection were isolated in ¼ dram vials, and held in a humidified environment until emergence. These individuals were used for the mating trials, and for electrophoretic study. In May of 1994, a second collection of *Eretmocerus* was made from the Rio Grande Valley in Texas and the same greenhouse in Tucson, Arizona for further electrophoretic study.

Mating trials.—Small Syracuse watch glasses (2 cm diam.) covered with a microscope slide were used as arenas in which to observe courtship and mating. The watch glasses were lined with a collard leaf disk bearing *Bemisia* nymphs. Females 24–48 h old were introduced to the arenas, and then males of similar age were introduced. The behavior of the wasps was observed using a dissecting microscope at 8× for 10 minutes, or until completion of a successful mating. A video camera was attached to the dissecting microscope and the behaviors videotaped for further analysis.

Females that were successfully mated were isolated on small caged collard plants bearing *Bemisia* nymphs. The pupal progeny were then collected and the adults sexed at emergence.

Allozyme analysis.—Samples of field-collected wasps from each of the three field populations and a sample of F1 and F2 progeny from successful matings were frozen in liquid nitrogen for allozyme analysis. Electrophoresis was performed by isoelectric focusing (IEF) of enzymes on 11 cm wide cellulose acetate membranes (Fuji Separax-EF, Wako Chemicals, Richmond), using the apparatus and methods described by Kazmer (1991) for three electrodes and an effective membrane size of 4.5 cm. Staining of cellulose acetate membranes for allozymes was according to standard recipes, with the stains applied in 0.75% (wt/vol) agar overlays (Bacto-agar, Difco Laboratories, Detroit).

Wasps from the three populations used in mating tests were initially screened in IEF runs using carrier ampholytes (Sigma Chemical, St. Louis) that create a pH 4–6.5 gradient between the cathode and anode. Insects were squashed directly onto membranes 1.8 cm from the cathode. By stacking three membranes, we were able to stain and resolve three polymorphic allozymes (isocitrate dehydrogenase, IDH; malate dehydrogenase, MDH; glucose-phosphate isomerase, PGI), with each membrane stained for one enzyme. F1 and F2 progeny from crosses were also electrophoresed to verify Mendelian segregation of alleles. A second run was carried out using wasps from second collections of wasps from the Texas field population and the Arizona greenhouse population. This time, carrier ampholytes that create a pH 5–8 gradient were used, which allowed us to resolve two additional enzymes (malic enzyme, ME; phosphoglucomutase, PGM). In this case, four membranes were stacked and stained, with one of the four membranes stained for both ME and MDH.

Alleles were identified by their distance from the cathode, with the most cathodal allele in each case designated the "a" allele. After genotypic data for each locus were recorded from stained membranes, population statistics and Nei's (Nei 1972) genetic distance were calculated by entering the data into BIOSYS-1 (Swofford and Selander 1989). In addition a modification of Nei's D that is less sensitive to variation among loci in gene substitution rates, D*, was calculated (Hillis 1984). Tests of Hardy-Weinberg genotypic proportions were carried out on data from females only, while pairwise measures of genetic distance between populations were calculated from

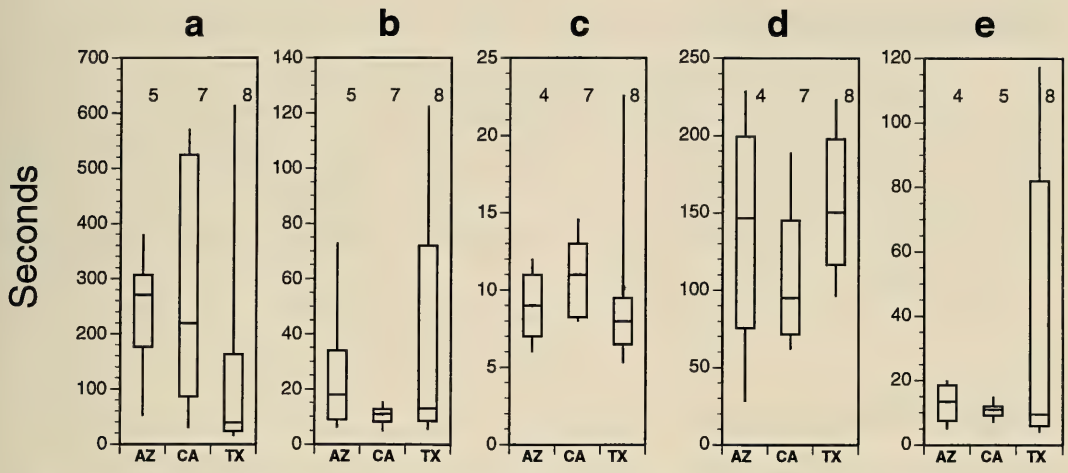

Fig. 1. Duration of courtship events in successful within-population matings. The bar that divides each box is the median value, the top and bottom of the box are the 25% and 75% quartiles and the lines extending beyond the box mark the range of values. The numbers above the boxes are the sample sizes. The figures indicate a, the time until the male mounts the female, b, the duration of precopulatory courtship, c, the duration of copulation, d, the duration of postcopulatory courtship, and e, the time until the female signals receptivity.

allele frequencies of males and females combined.

Results

There was no evidence that courtship behavior differed between the three populations. No unique behaviors were observed in any of the three populations, and there was as much variation found in the sequence and frequency of particular behaviors within populations as between populations. Furthermore, no statistically significant differences between populations were found in the duration of each phase of courtship (Kruskall Wallis test, Fig. 1). For this reason, the description of courtship behavior that follows is based on observations from all three populations.

Courtship behavior.—A male placed in an arena with a female walks rapidly while vigorously antennating the substrate. When a female is encountered the male generally approaches from the side, antennates briefly and attempts to mount. The attempted mounting may be preceded by the male circling the female. Males will attempt to mount walking or motionless females. Females often appear to be arrested upon the approach of a male, with their antennae and abdomen lowered. However, the female may jump away when mounting is attempted; both motionless and moving females have been observed to jump. If the female jumps, the male resumes his search. If the male mounts successfully he stands on the female with his foretarsi on the females head, usually on her eyes, his midtarsi below the wings on the gaster, and his hind tarsi on the female's wings (Figs. 2, 3a).

Precopulatory courtship begins with a relatively long period of antennation and may be accompanied by occasional 'foreleg rubbing,' or one or more wing fans. The end of the precopulatory 'cycle' (sensu van den Assem 1986) is composed of two distinct behaviors: a wing fan and two or three swinging movements of the midlegs. The male then usually backs up to attempt copulation.

Antennation by the male is vigorous, with the mid section of the long, unsegmented male clubs touching the tips of the female antennae (Fig. 3a). Unlike some other chalcidoids, for example the Pteromalinae (van den Assem 1986), female receptivity does not appear to be signaled by

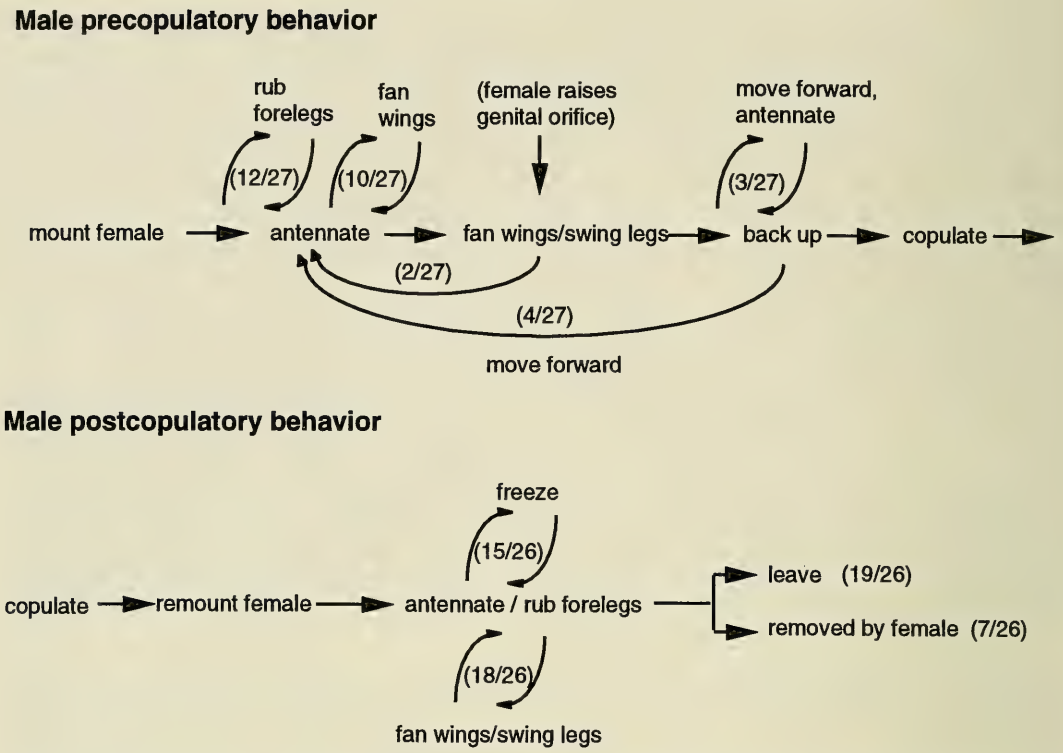

Fig. 2. The sequence of precopulatory and postcopulatory courtship behaviors in successful matings. When a behavior was not universally performed, the fraction of males that performed that behavior is given.

clear changes in antennal position. Female antennal clubs do not usually drop at any point in the cycle. Foreleg rubbing is sometimes a part of precopulatory courtship but is an integral part of postcopulatory courtship (Fig. 2). In this behavior, males lift each of their foretarsi from the females eyes alternately. They may simply retract the leg towards their body and then replace it on the female eye, or perform a more elaborate behavior. In the latter, the tarsus is first crossed under the body until it touches the mesopleuron with the tibia and femur flat against the venter, then the femur-tibia joint is extended downward (Fig. 3b). The femur-tibia joint is then retracted so the leg is again flat across the venter, and the tarsus is drawn back across the body and returned to its original position. This entire action is very rapid, about one second in total duration, and it is difficult to determine the nature of the signal being communicated. This behavior has not been recorded as a part of courtship in parasitic wasps to our knowledge, and we discuss its possible significance below. The end of precopulatory courtship is signaled by a wing fan by the male. This may be a simple flip above the dorsum without extending the wings (Fig. 3c), or the male may also extend the wings outward and down so that they are perpendicular to the long axis of the body and level with the dorsum, and then return them to their resting position. In conjunction with the wing fan or immediately following, the midlegs are swung forward in parallel so that the tarsi pass in front of the females eyes and are then returned (Fig. 3d). The 'leg swing' is usually repeated twice, although some males swing their legs three times and fewer swing their legs once or four times. There is also between-male variation in the nature of the leg swings. Some males swing their legs asynchronously, and

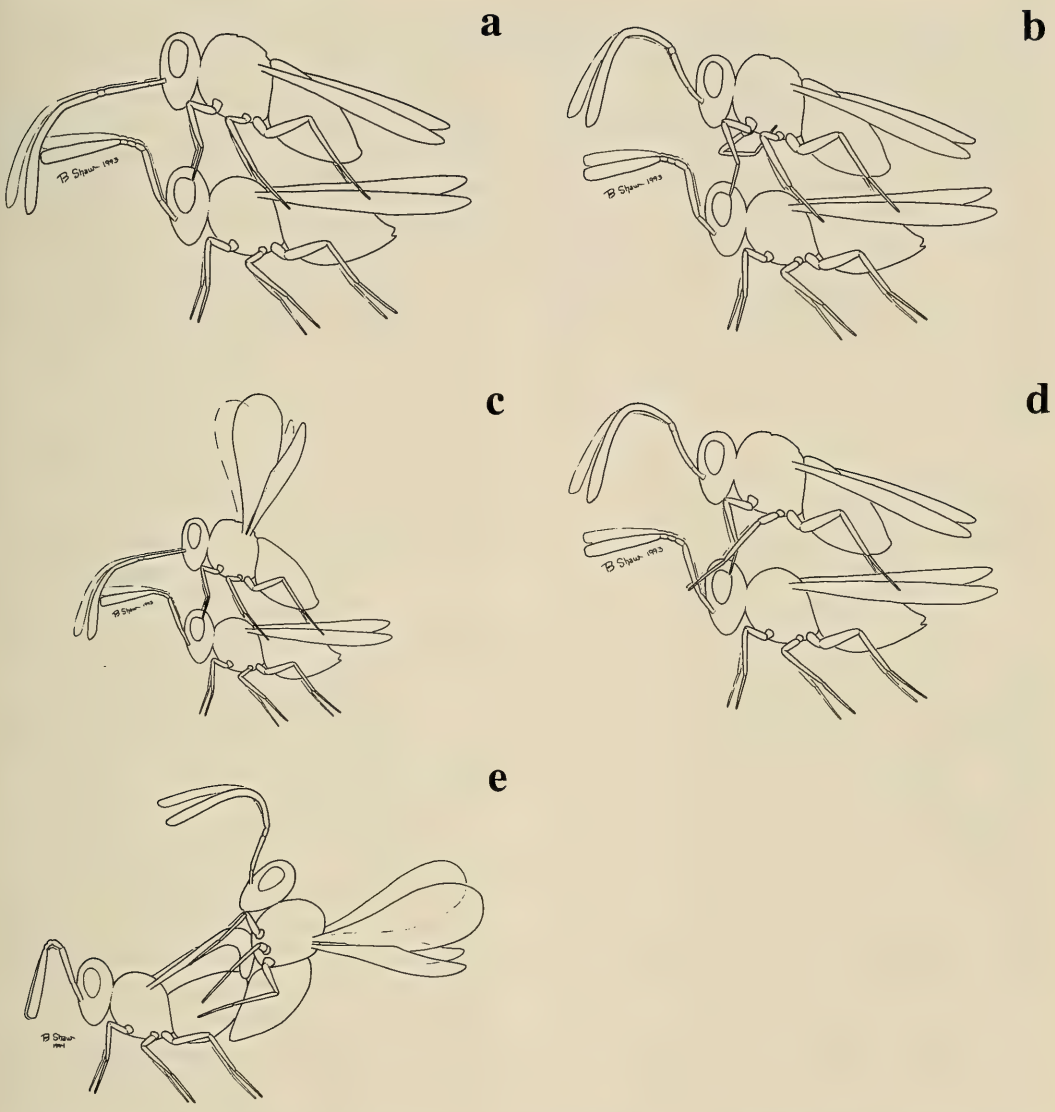

Fig. 3. Courtship behaviors. a, Antennation. b, Foreleg rubbing. c, Wing fanning. d, Midleg swings. e Copulation.

sometimes one of the tarsi hits the female head in the forward swing. Receptive females usually lift the metasoma (exposing the genital orifice) at the time the mid tarsi of the male cross in front of the female eyes for the first or second swing. The mean duration of the precopulatory phase of courtship is 30 seconds ± 9 SE. The leg swings are generally followed by the male backing up to attempt copulation, regardless of whether the female has signaled her receptivity. The exceptions generally occur when the female is actively trying to remove the male; in these instances the male may simply begin the cycle again.

As the male adopts the copulatory position, the female wings are lifted slightly, and flexed downward at the ends by the male. In the male copulatory position the wings serve as a prop against the substrate, the forelegs grip the margins of the wings of the female and the mid and hind legs are

on the female metasoma (Fig. 3e). The duration of copulation is on average 12 seconds ± 1.7 SE, after which the male returns to the mounted position and begins postcopulatory courtship.

Postcopulatory courtship is composed of many of the same behaviors as in the precopulatory cycle, although the frequency and order is different (Fig. 2). Much of the time is spent alternating between antennating and foreleg rubbing or doing both synchronously. Males touch either the middle or distal third of their club to the tip of the females antennae, as in precopulatory courtship; there is no clear pattern in the order or frequency of the two types of antennation. The postcopulatory foreleg rubbing is more pronounced and is performed by all males. Postcopulatory males may 'freeze' and stand motionless on the female. The male may then resume antennation and/or foreleg rubbing, sometimes apparently in response to movements by the female. The wing fan/leg swing behavior is also a frequent component of postcopulatory courtship, but it may be performed at any time and does not appear to signal the end of courtship. Either the male or the female may end postcopulatory courtship; males dismount to the side and walk away at approximately 90° from the female head, while females may dislodge the male after beginning to walk or groom. The duration of postcopulatory courtship (mean 144 seconds ± 11.31 SE) was not significantly different when ended by males compared to females (t = 1.29, df = 24).

The courtship of unreceptive females is characterized by many repetitions of the courtship cycle. While apparently identical to courtship of receptive females initially, the nature of the courtship of unreceptive females is often altered by progressively more strenuous evasive behaviors by the female. Males commonly court far forward of the normal position with their body tilted forward over the female head; reasons for this may include better access to antennae which may be lowered by unreceptive females, and less leverage allowed females that may raise their wings in an apparent attempt to lift the hind legs of the male and tilt him forward and over the female's head. In addition, cycles may be longer as males antennate longer before attempting the wing fan/leg swing behavior. Lastly, the male may not back up after leg swinging if the female is still trying to dislodge him.

Reproductive relationships.—Copulation was never observed between Texas individuals and individuals from either Arizona or California (Table 1). In contrast, there was no significant difference between the frequency of within- and between-population matings in the Arizona and California populations. Interestingly, in reciprocal crosses between Arizona and California, females signaled acceptance more frequently than males succeeded in mating (Table 1). This may have been due to size differences between the two populations (Table 2); in some instances size incompatibility of the male and female appeared to present a physical barrier to mating.

Relatively few of the California and Arizona females reproduced, and those that did had a lower fecundity than did the Texas females (mean no. of progeny, California, 10.50 ± 2.19 SE, n = 6 of 10 females; Arizona, 8.5 ± 4.44 SE, n = 4 of 9 females; Texas, 38.86 ± 7.44 SE, n = 7 of 9 females). The poor reproduction of the Arizona and California females may have been due to the choice of the host plant, collards, for rearing of the F1 progeny. While the Texas population was collected from cabbage, *E.* nr. *californicus* is not generally recovered from *Bemisia* on crucifers in California, even when planted adjacent to plants bearing *Eretmocerus* (Roltsch and Pickett 1994, M. Rose, pers. obs.). These observations suggest there may be differences in host plant affinities between the Texas *Eretmocerus* and the other two populations.

The sex ratio (proportion males) of progeny from crosses between the Arizona and California populations (s.r. = 0.42, n = 33),

Table 1. Summary of within- and between-population mating trials of three populations of *Eretmocerus* sp. nr. *californicus*.

	Trials	Male mounted	Female accepted	Copulation occurred
Within populations				
Texas	10	10	9	9
Arizona	6	5	5	5
California	10	8	7	7
Between populations				
Texas–Arizona	16 (10/6)[1]	13 (10/3)	0***	0***
Texas–California	20 (10/10)	13 (7/6)	0***	0***
Arizona–California	16 (6/10)	11 (5/6)	10 (5/5)	7 (4/3)

[1] The frequencies of the two reciprocal crosses. The first number corresponds to the trial in which females from the population listed first were mated to males of the population listed second.

*** Frequencies in these cells were significantly different (χ^2, 1 df, $P < 0.001$) from the summed frequencies of the two relevant within-population trials.

were no more male-biased than the sex ratios of either the within-population Arizona (s.r. = 0.48, n = 21) or California (s.r. = 0.42, n = 45) crosses. These data suggest there are no postcopulatory reproductive barriers to gene flow between these two populations.

Allozyme analysis.—For two of the five allozymes, there was considerable divergence in allele frequencies between the Texas population and the populations from Arizona and California (Tables 3, 4). The IDH-c allele is more common in the California and Arizona populations while the alternative alleles are more common in the Texas population (Tables 3, 4). Similarly the ME-a allele is more common in the Arizona population, while the ME-b allele is more common in the Texas population (Table 4). MDH, PGI, and PGM showed similar allele frequencies in all populations, although two MDH alleles (MDH-a and MDH-d) were unique to the Texas population (Tables 3, 4). In the Texas population, allele frequencies of the PGI locus changed from the first to the second collection, with the appearance of the PGI-c allele and the disappearance of the PGI-a allele (Tables 3, 4). It is not clear why this between-year difference occurred in the Texas population, but small differences in the time of year collected, geographic location, and collections from a greater variety of host plants in 1994, including cotton and melon as well as cabbage, may have contributed to the difference in allele frequencies at this locus. In all cases, genotype frequencies conformed with Hardy-Weinberg expectation, and allele frequencies of males and females were similar. Samples of the F1 and F2 progeny when compared to parental allozyme patterns supported a Mendelian inheritance pattern for the three loci tested in the 1993 sample.

Table 2. Comparisons of the lengths of the hind tibiae, in microns.

Population[1]	n	Females[2]	Males
Arizona	19	196 ± 5 SE	187 ± 5 SE
California	20	212 ± 6 SE	197 ± 5 SE
Texas	20	219 ± 4 SE	220 ± 2 SE

[1] Hind tibia length is significantly different among populations ($F_{2,53} = 35.18$, $P < 0.001$), and between Arizona and the other two populations ($F_{1,55} = 20.79$, $P < 0.001$).

[2] Hind tibia length is significantly different between sexes ($F_{1,53} = 4.09$, $P < 0.05$).

Genetic distances (both Nei's D and Hillis' D*) estimated from combined gene frequencies of males and females differed be-

Table 3. Allele frequencies from three loci in three populations of *Eretmocerus* nr. *californicus* sampled in 1993. N refers to the number of individuals sampled for each locus.

	Arizona			California			Texas		
	Males	Females	Combined	Males	Females	Combined	Males	Females	Combined
Alleles									
(N)	(16)	(1)		(24)	(14)		(46)	(20)	
IDH-a	—	—	0.000	—	—	0.000	0.087	0.150	0.116
IDH-b	—	—	0.000	0.083	—	0.038	0.870	0.850	0.860
IDH-c	1.000	1.000	1.000	0.917	1.000	0.962	0.043	—	0.023
(N)	(26)	(1)		(34)	(15)		(32)	(21)	
MDH-a	—	—	0.000	—	—	0.000	0.031	0.048	0.041
MDH-b	1.000	1.000	1.000	0.853	0.933	0.891	0.969	0.881	0.919
MDH-c	—	—	0.000	0.147	0.067	0.109	—	0.048	0.027
MDH-d	—	—	0.000	—	—	0.000	—	0.024	0.014
(N)	(27)	(1)		(34)	(15)		(32)	(21)	
PGI-a	—	—	0.000	0.147	0.200	0.172	0.033	0.119	0.083
PGI-b	1.000	1.000	1.000	0.853	0.800	0.828	0.967	0.881	0.917
PGI-c	—	—	0.000	—	—	0.000	—	—	0.000

tween the two electrophoretic runs. When all three populations were examined for three loci, genetic distance (D) between the Arizona and California was only 0.011 while the distances between these two populations (Arizona and California) and Texas, were 0.377 and 0.394, respectively. In the second run, with a larger sample and a greater number of loci, the distance between the Texas and Arizona populations was 0.701. Hillis' D* (1984), which was designed to be less sensitive to variation in gene substitution rates among loci, gave very similar estimates of genetic distance. For the first run, the D* between Arizona and California was 0.010, while the dis-

Table 4. Allele frequencies from five loci in two populations of *Eretmocerus* nr. *californicus* sampled in 1994. N refers to the number of individuals sampled.

	Arizona			Texas		
	Males	Females	Combined	Males	Females	Combined
Alleles (N)	(32)	(43)		(19)	(50)	
IDH-a	—	—	0.000	0.500	0.540	0.539
IDH-b	—	0.035	0.025	0.444	0.410	0.415
IDH-c	1.000	0.965	0.975	0.056	0.050	0.051
MDH-a	—	—	0.000	—	0.020	0.017
MDH-b	1.000	1.000	1.000	1.000	0.960	0.966
MDH-c	—	—	0.000	—	0.010	0.008
MDH-d	—	—	0.000	—	0.010	0.008
ME-a	1.000	1.000	1.000	0.211	0.060	0.084
ME-b	—	—	0.000	0.789	0.940	0.916
PGI-a	0.031	—	0.008	—	—	0.000
PGI-b	0.969	1.000	0.992	0.474	0.270	0.303
PGI-c	—	—	0.000	0.526	0.730	0.697
PGM-a	0.031	—	0.008	—	0.030	0.025
PGM-b	0.594	0.430	0.475	0.474	0.520	0.513
PGM-c	0.375	0.570	0.517	0.526	0.450	0.462

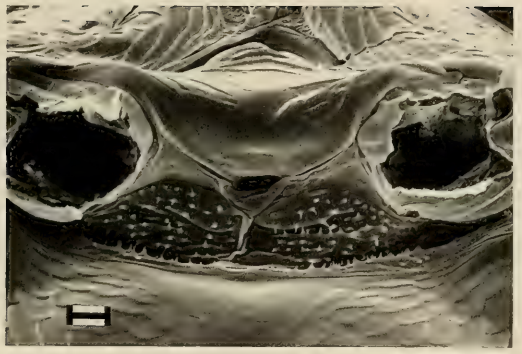

Fig. 4. Scanning electron micrograph (1000×) of epicoxal pads under the forelegs of a Texas *E.* nr. *californicus* male. Scale bar = 10 μm.

tances between Arizona and Texas, and California and Texas were 0.395 and 0.378, respectively. In the second run, the difference between Texas and Arizona was 0.663.

Discussion

Courtship behavior.—Courtship in the three populations of *Eretmocerus* nr. *californicus* shared some attributes with other genera in the Aphelinidae. The courtship behavior of several species of *Aphytis,* a large genus of primary parasitoids of armored scale insects which are also in the Aphelininae (Rosen and DeBach 1979), was thoroughly explored by Gordh and Debach (1978). The precopulatory sequence is abbreviated (3.3 secs on average) and appears to consist only of antennation. The importance of functional antennae in consummating courtship in *Aphytis* was demonstrated by removing the club segments of both males and females; interference with antennal function of either sex prevented copulation (Gordh and DeBach 1978). The courtship stance of male *Aphytis* is similar to *Eretmocerus,* but the midlegs hang free and do not touch the body of the female. Like *Eretmocerus,* females do not appear to signal their acceptance by a change of antennal position, but simply by a change of the metasomal position. Unlike *Eretmocerus,* male *Aphytis* copulate with their hind legs on the substrate. Postcopulatory courtship of *Aphytis* involves antennation, frequent wing fanning and swinging of the mid legs ("semaphoral" movement) in a manner that resembles *Eretmocerus.* The tarsi of *Aphytis* males do not appear to pass very close to the female's eyes, however. While the timing of female acceptance in *Eretmocerus* suggest that females respond to the sight of the tarsi crossing before their eyes, Gordh and Debach (1978) suggest that this movement in *Aphytis* might move pheromones produced by the male thorax. Wing fanning in *Aphytis* is more frequent than in *Eretmocerus* and is performed by males on approach to females as well as during courtship. It is not used in combination with leg swings as it is in *Eretmocerus.* Finally, the foreleg movement observed in *Eretmocerus* is not seen in *Aphytis.* While Gordh and DeBach (1978) might conceivably have missed this very rapid movement without the video recording technology that allows frame by frame observation, we believe the behavior is more likely absent in *Aphytis* because elaborate foreleg movement would seem potentially unstable when the midlegs are not anchored on the female.

The nature of the cues being communicated by foreleg rubbing are unknown but one possibility is that leg movement causes vibrations of some enigmatic structures called the epicoxal pads (Fig. 4). Epicoxal pads appear throughout the subfamily Aphelininae (J. Woolley and M. Hayat pers.

comm.). They were first observed in *Aphytis* by Rosen and DeBach (1979) who suggested that they might have an acoustic function, particularly in courtship. Although the foreleg rubbing of *Eretmocerus* males in courtship would appear to support this idea, there are some problems with this explanation. Females as well as males have epicoxal pads. Furthermore, epicoxal pads are present in taxa such as *Aphytis* where they do not appear to be used in courtship. Performing auditory recordings of *Eretmocerus* courtship would be a first step toward resolving the function of these structures.

Courtship in the more distantly related aphelinid genus *Encarsia* is highly variable; postcopulatory courtship may be absent or persist for up to 26 minutes, and the duration of copulation also varies (Viggiani and Battaglia 1983, Kajita 1989). Leg movements appear to be absent in the species studied, and wing fanning is infrequent; instead antennation appears to replace other behaviors and may involve a number of antennal movements and positions (Viggiani and Battaglia 1983). Like *Aphytis* males, *Encarsia* males support themselves with their hind legs during copulation (Viggiani and Battaglia 1983, Kajita 1989).

Reproductive relationships.—Reproductive incompatibility between populations is generally a result of genetic differentiation of one or more of a suite of behavioral and physiological characters, and is commonly recognized a good indicator of species limits. However, misinterpretation is possible, especially if there are environmental influences on reproductive relationships, or if the presence of continuous variation among several populations is interpreted as discontinuous because only populations at the extremes are tested (Pinto et al. 1991). For this reason, corroboration of reproductive relationships with character systems such as morphology or enzyme patterns is desirable.

In this study the mating trials were clearly supported by the electrophoretic results. The Texas population is distinguished from the other two by two unique MDH alleles, and both IDH and ME show consistent allelic differences between Texas and the others. The genetic distances between the Texas population and populations from Arizona and California are consistent with values commonly found between species of other parasitoid wasps (Kawooya 1983, Unruh et al. 1989, Pinto et al. 1992, Pinto et al. 1993) and among *Drosophila* species (Coyne and Orr 1989). The genetic distances between the Arizona and California populations are more like those found between populations within a species. In concert, these separate lines of evidence support our contention that the Texas *Eretmocerus* is a distinct species from the *Eretmocerus* collected in Arizona and California. These will be described as new species (M. Rose and G. Zolnerowich, in litt.).

Acknowledgments

All determinations were made by Mike Rose. A sample of the individual wasps used in the mating trials were mounted as voucher specimens and deposited in the private collection of Mike Rose. The authors are grateful to Holly Glenn, Kim Hoelmer, Oscar Minkenberg, and Charlie Moomaw for sending field collected material in a very timely manner. Greg Zolnerowich took the SEM micrographs of the epicoxal pads on the Texas *Eretmocerus*. Ty Vaughn assisted with the electrophoretic studies. Ben Shaw illustrated the mating behavior from video stills. We also express our gratitude to Ray Carruthers for his encouragement and support on this project, and to Jim Woolley for his thoughtful comments on the manuscript.

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NEW TAXA AND KEY TO THE TRIBES AND GENERA IN TRIBELOCEPHALINAE STÅL 1866 (HETEROPTERA: REDUVIIDAE)

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Abstract.—*Xenocaucus* China and Usinger 1949, is fixed as type of the new tribe **Xenocaucini** of Tribelocephalinae. ***Abelocephala***, new genus, and ***A. thai***, new species, is described from Thailand. Key to the tribes and genera in Tribelocephalinae is given. *Tomolus* Stål is redescribed, the holotype is fixed, and a paratype of *Tomolus costalis* redescribed.

Key Words: Reduviidae, Tribelocephalinae, Xenocaucini n. tribe, generic key

The Tribelocephalinae occur in the Oriental, Australian, and Ethiopian regions. It is a small group of medium sized, dull colored, nocturnal insects. They live among debris and in crevices (Villiers 1943). The fore wings are occupied mostly by the membrane, the clavus and the corium are small or poorly defined. Most genera have three-segmented tarsi. The genera *Apocacus* Distant, *Gastrogyrus* Bergroth and *Homognetus* Bergroth have two-segmented tarsi. *Xenocaucus* has one-segmented tarsi. Pilosity occurs in the Tribelocephalini in varying degrees and distribution, reaching its maximum in *Xenocaucus*.

Abelocephala thai new genus and species are described below. *Tomolus costalis* is redescribed and the holotype of the genus is fixed. The subfamily now contains 15 genera. The African *Tribelocephala* Stål, contains the largest number of species, and the Oriental *Opistoplatys* Westwood is the second largest.

Villiers (1943) established Opisthoplatini and Tribelocephalini and keyed the species in *Afrodecius* Jeannel and *Tribelocephala*. China and Usinger (1949) (in my Catalogue to the World Reduviidae (1990: 569) I erroneously give China and Miller as authors) described *Xenocaucus mancini,* from Fernando Poo, but did not assign it to any tribe. Herein I establish Xenocaucini as a new tribe with *Xenocaucus* as the type. This is quite an aberrant genus, with several unique characters.

KEY TO THE TRIBES AND GENERA IN TRIBELOCEPHALINAE

1. Apterous, eyeless, tarsi one-segmented; first antennal segment, head and pronotum laterally thickly setose; I antennal segment broadly concave longitudinally (Fig. 44) Xenocaucini Maldonado new tribe . . . . . *Xenocaucus* China and Usinger
– Winged, with eyes, tarsi two- or three-segmented; glabrous or less densely setose, with different distributional pattern; antennae cylindrical 2
2. Hemelytra with base of inner discal cell divided in two by cross vein m-cu, thus with well defined cubital cells (Figs. 10, 19, 36); tarsi three-segmented . . . Opistoplatyini Villiers 3
– Hemelytra with base of inner discal cell not divided in two by a cross vein, thus without basal cubital cells (Figs. 3, 9); tarsi three or two-segmented . . Tribelocephalini Villiers . . 6
3. Scutellum triangular; posterior margin of head setose, setae extended laterally and then forward underneath to base of rostrum (Fig. 20) . . . . . *Distantus* Villiers

– Scutellum short, almost semicircular; posterior lobe of head glabrous or differently setose . . 4
4. Posterior lobe of head with margins curved slightly to a very short neck hidden by pilosity; anterior lobe of pronotum semicircular, with lateral angles elevated, located and projected posteriorly (Fig. 11) . . . . . *Centrogastrocoris* Miller
– Posterior lobe of head with sinuous margins converging to a long neck; anterior lobe of pronotum rectangular, antero-lateral angles round, projected forward or laterad 5
5. Tylus not projected; anterior lobe of pronotum bigibbous; head twice as long as pronotum; eyes dorsally ⅓ as long as postocular region (Fig. 33) . . . . . *Opistoplatys* Westwood
– Tylus projected, slightly upcurved; lobules of anterior lobe of pronotum slightly elevated; head slightly longer than pronotum; eyes half as long as postocular region (Fig. 35) . . . . . *Plectophorocoris* Miller
6. Head above with conspicuous thick clothing of long, erect pubescence (Fig. 30) 7
– Head above glabrous or with short, fine, decumbent pubescence 8
7. Vertex deeply sunken (Fig. 30), pubescence leaflet-like . . . . . *Megapocaucus* Miller
– Vertex not sunken, pubescence fine (Fig. 8) . . . . . *Apocaucus* Distant
8. Tylus projected upward or forward as a strong spine, above or beyond apex of clypeus . . . 9
– Tylus blunt, not or slightly projected forward 10
9. Anterior angles of pronotum projected forward; tylus not surpassing base of clypeus; antennophores not projected laterally (Figs. 1, 2) . . . . . *Acanthorhinocoris* Miller
– Anterior angles of pronotum round; tylus surpassing base of clypeus; antennophore projected laterally (Figs. 42, 43) . . . . . *Tribelocephala* Stål
10. Antennophore protected laterally by a small sclerite (Figs. 4, 6); II rostral segment thick, III rostral segment very short, chelate (Fig. 5); anteocular region shorter than postocular, anteocular short setose, postocular with long setae pointing backward . . . . *Afrodecius* Jeannel
– Without such sclerite protecting base of antennophore; rostrum slender throughout, III rostral segment short, not chelate; ante- and postocular regions variable in length, if setose with a different pattern 11
11. Ante- and postocular regions subequal in length, eyes and antennae set about midlength of head; head twice as long as wide (Fig. 38); posterior lobe of head slightly tapering backward, meeting a very short, mostly hidden collum (Fig. 38) . . . . . *Tomolus* Stål
– Anteocular region about half as long as postocular; eyes and antennae set forward; head less than twice as long as wide, posterior lobe of head tapering backward to an exposed, long, collum 12
12. Head with a membranous fringe at base above that extends laterally and then forward underside (Fig. 21) to form what authors have mistaken with a rostral groove 13
– Head without such membranous fringe 14
13. Anterior lobe of pronotum horizontal, without tubercles; pronotum twice as wide basally as long . . . . . *Gastrogyrus* Bergroth
– Anterior lobe of pronotum sloped forward, with 2+2 tubercles (Figs. 24, 25); pronotum slightly wider than long . *Homognetus* Bergroth
14. Head mostly glabrous, on lateral view about half as high as long; anterior lobe of pronotum glabrous, with 1+1 small interlobular tubercles; rostrum thick, I rostral segment half as long as II (Fig. 26) . . . *Matangocoris* Miller
– Head setose (Figs. 13, 14), on lateral view almost as high as long; pronotum without tubercles, anterior lobe setose; rostrum slender, I rostral segment almost 3 times as long as II (Fig. 14) . *Abelocephala* Maldonado new genus

Annotated Checklist and Synonymy of Tribelocephalinae Genera

Opistoplatyini Villiers

Villiers A. 1943, 10: 9. New tribe, type *Opistoplatys*. *Centrogastrocoris* Miller 1958, 9: 37. Range—New Guinea, 2 species. Emended name for *Centrogastocoris,* Miller intended abdomen, i.e. *gastro.* Figs. 11–14. Fig. 11 is copied from Miller (1958); however, on lateral and dorsal view the clothing of the head is similar to that of *Distantus* (Figs. 18, 20), he described it simply as "tomentose."

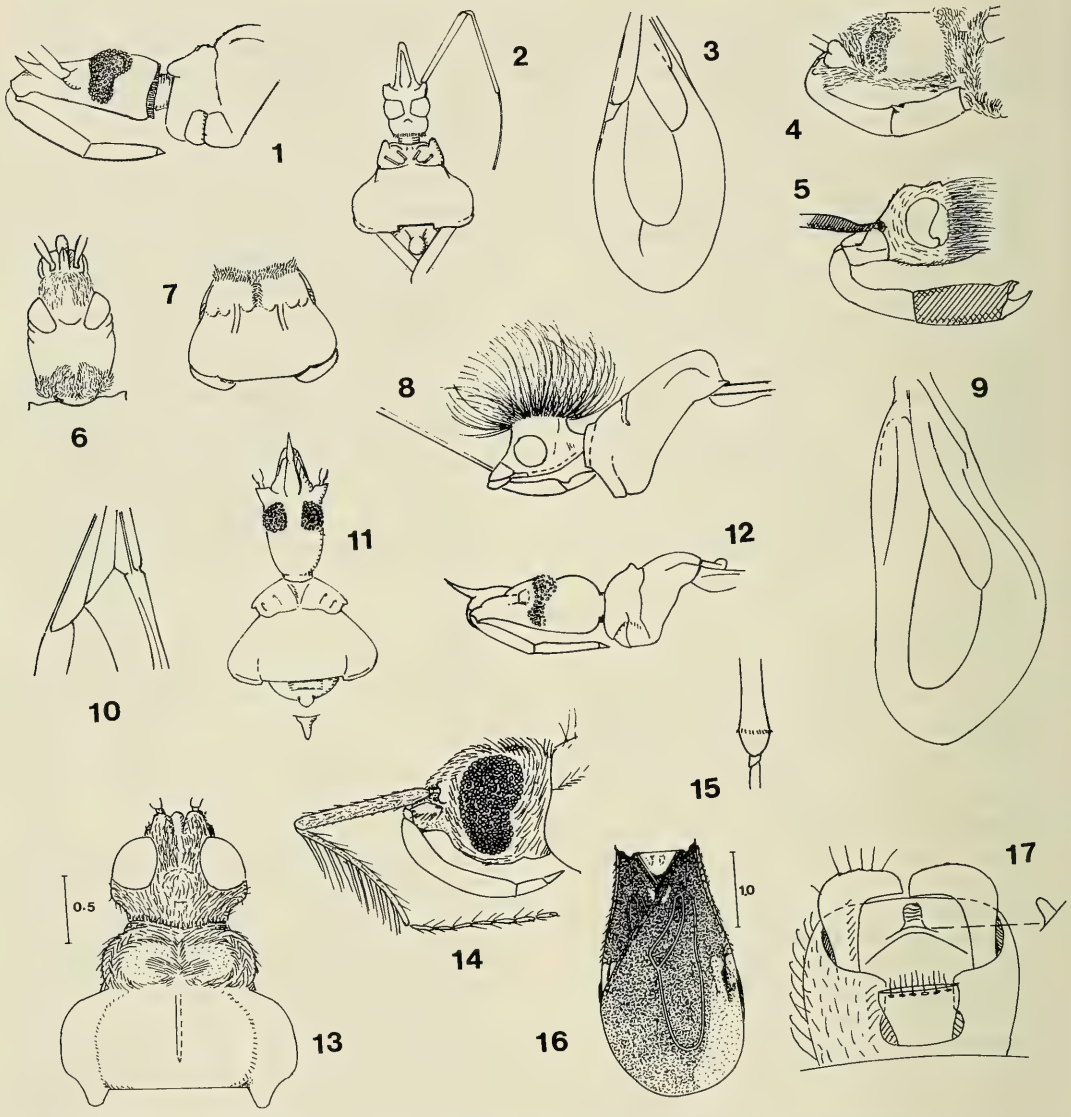
Distantus Villiers 1943, 10: 9, 21. Range—Africa, Fernando Poo, 2 species. Figs. 18–20.

Opistoplatys Westwood, 1834, 20: 447. *Decius* Stål, 1859 and *Pangeranga* Distant 1906, are synonyms. Range—Oriental, Australian, 22 species. Figs. 33, 34.

Plectophorocoris Miller 1958, 9: 40. New Guinea, monotypic. Figs. 35–37.

Tribelocephalini Villiers

Villiers A. 1943, 10: 9. *Tribelocephala* as type.



Figs. 1–17. 1, 2, *Acanthorhinocoris* sp. 1, Head and pronotum, lateral view. 2, Head, pronotum and scutellum, dorsal view. 3–7, *Afrodecius* spp. 3, Hemelytron. 4, *A. ghesquieri,* head, lateral view. 5, *A. lycoides,* head, lateral view. 6, *A. ghesquieri,* head, dorsal view. 7, *A. delamarei,* pronotum, dorsal view. 8, 9, *Apocaucus sinicus.* 8, Head and pronotum, lateral view. 9, Hemelytron. 10–12, *Centrogastrocoris* sp. 10, Basal half of hemelytron. 11, Head, pronotum, scutellum, metascutellum, dorsal view. 12, Head, pronotum, scutellum, lateral view. 13–17, *Abelocephala thai,* male holotype. 13, Head and pronotum, dorsal view. 14, Head, lateral view. 15, Comb on protibia, lateral view. 16, Hemelytra. 17, external genitalic sclerites, dorsal view.

Abelocephala Maldonado, New Genus

Type of genus *Abelocephala thai* Maldonado, new species.

Male—Head (Figs. 13, 14) slightly longer than wide, on lateral view almost as high as long, subequal in length to pronotum, eyes large, reaching upper but not lower margin of head, first rostral segment reaching level of anterior margin of eye. Anterior lobe of pronotum slightly shorter and about $^4/_5$ as wide as posterior, setose;

scutellum triangular; legs slender, posterior the longest; hemelytra without cubital cells (Fig. 16). Species small, under 4.10. Female unknown.

Abelocephala thai Maldonado, New Species
(Figs. 13–17)

Male—light gray due to its abundant gray pilosity, eyes gray; anterior lobe of pronotum covered with dense, silvery, fine setae; posterior lobe pale brown, legs brownish yellow; hemelytra: cell area dark brown, inner marginal area grayish, outer marginal area brownish-yellow, abdomen brown.

Head—length 0.65, width across eyes 0.6, interocular space 0.21; a false, round ocellar callus narrower than interocular space, interocular furrow poorly defined; wider behind eyes than across eyes, anterior lobe to interocular sulcus 0.25, posterior lobe 0.35 long. Antennal segments: I, 0.7; II, 0.75; III, and IV together 0.87, formed by 4 or 5 pseudosegments; I and last two segments short, decumbent setose, II segment long, vertical setose. Rostrum glabrous, length of segments: I, 0.6; II, 0.2; III, 0.12. Pronotum: length and width of anterior lobe 0.3 and 0.8, length and width of posterior lobe 0.40 and 1.05; anterior lobe with dense decumbent and vertical setae, partially hiding C-shaped glabrous 1+1 areas; hind lobe glabrous, polished. Scutellum triangular, with median sulcus, length 0.31, basal width 0.50, apex round, with vertical and decumbent setae. Meso- and metapleura densely setose. Margins of meso- and metasternum silvery setose. Seta of legs short, decumbent; protibia with a preapical whorl of minute spines (Fig. 15); lengths of femora 0.94, 0.81, 1.19, of tibiae 0.87, 0.87, 1.37; first tarsal segment very short, last two subequal; pairs of coxae separated from each other by at least a coxal width. Hemelytra venation as in Fig. 16; length 2.93, width 1.75, wider than abdomen, surpassing apex of abdomen by about 0.68. Abdomen oval, length 2.25, width 1.50; suture between metasternum and first abdominal sternum with compact, short, silvery setae; sutures between sterna obsolete. External genitalia as in figure 17. Overall length of body 3.93–4.06.

Holotype—male, THAILAND, Ratburi, 28.II.52, RE Elbel collector, in the National Museum of Natural History, Washington, D.C. Paratypes—2 males, same collecting data, one in JMC, the other in NMNH. Etymology—*Abelocephalus* means head without spines (*belo*), *thai* the place of collection.

Acanthorhinocoris Miller 1940, 18: 432. Oriental, monotypic. Figs. 1, 2.

Afrodecius Jeannel 1919, 3: 165. Range—African, 8 species. Figs. 3–7.

Apocaucus Distant 1909, 3: 507. Range—India, China. Figs. 8–10.

Gastrogyrus Bergroth 1921, 1: 69. This genus and *Homognetus* have been described erroneously as having transparent, tingid-like bucculae. See couplets 3 and 12 of key for correct interpretation of this character. Range—Borneo, monotypic. Figs. 21–23.

Homognetus Bergroth 1923, 3: 18. Range—Borneo, monotypic. Illustrated for the first time in Figs. 24, 25.

Matangocoris Miller 1940, 18: 430. Range—Sarawak, monotypic. Figs. 26–29.

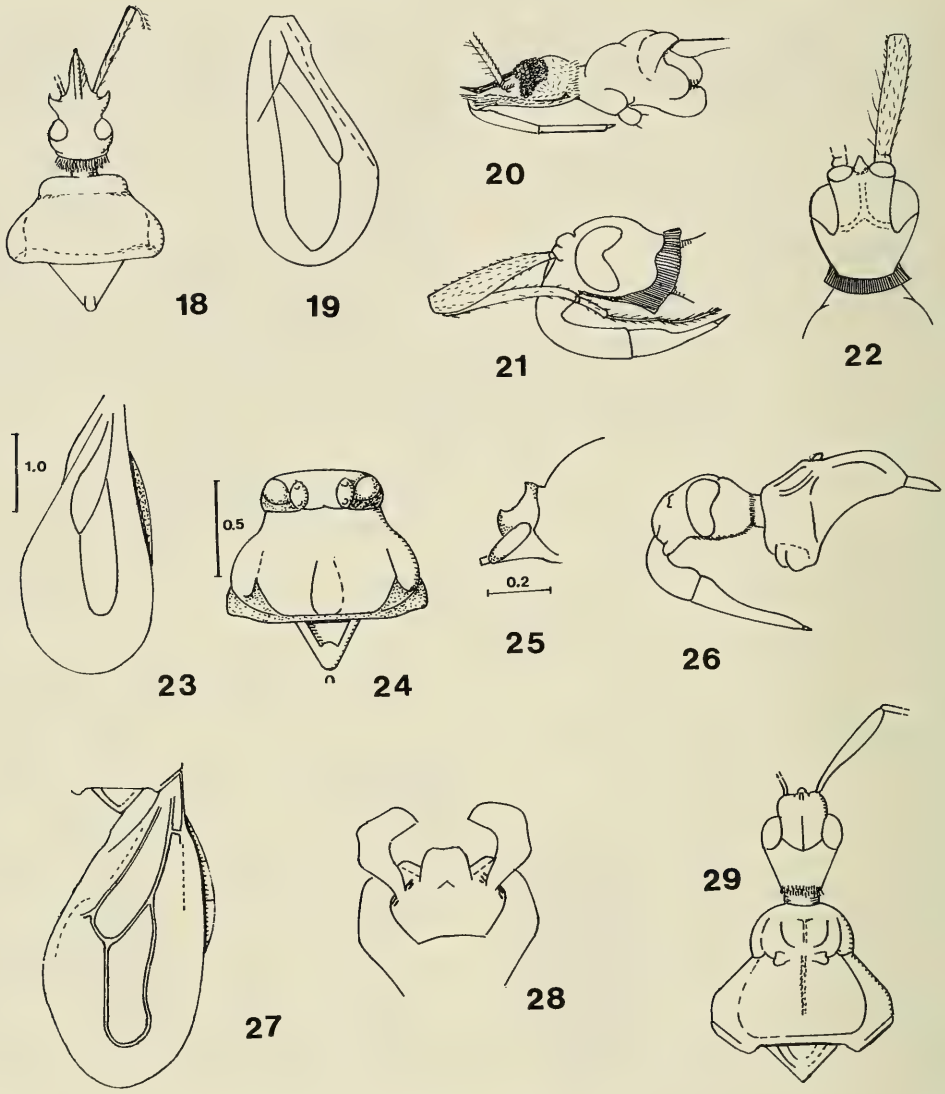
Megapocaucus Miller 1954, 10: 1. Range—Java, monotypic. Figs. 30–32.

Tomolus Stål 1874

Stål 1874, 4: 90. From Sumatra, monotypic. Illustrated for the first time in Figs. 38–41.

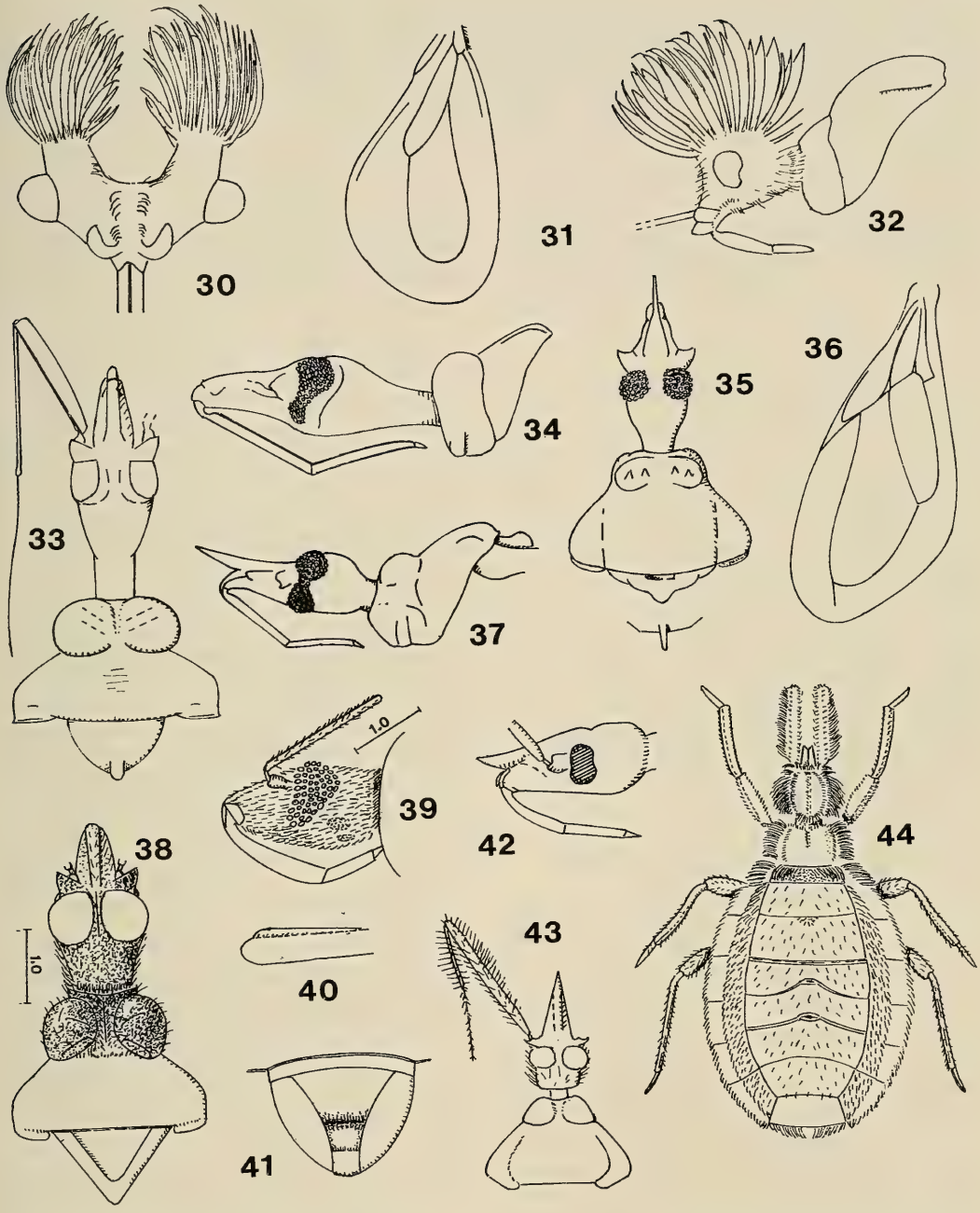
Redescription of female paratype—head grayish; appendages, connexivum above, posterior lobe of pronotum and costal margin of hemelytra brownish yellow (Stål: "flavescente ferrugineo"); anterior lobe of pronotum brown, mesopleura and abdominal sterna dark brown; hemelytra blackish mostly, margined with brownish yellow.

Head (Figs. 38, 39): decumbent short setose, ventrolaterally behind eyes with two



Figs. 18–29. 18–20, *Distantus oculatus.* 18, Head, pronotum, scutellum dorsal view. 19, Hemelytron. 20, Head, pronotum, lateral view. 21–23, *Gastrogyrus monophleboides.* 21, Head, lateral view. 22, Head, dorsal view. 23, Hemelytron. 24, 25, *Homognetus nigripennis.* 24, Pronotum, scutellum, metascutellum, dorsal view. 25, Anterior lobe of pronotum, lateral view. 26–29, *Matangocoris barbatus.* 26, Head, pronotum, scutellum, lateral view. 27, Hemelytron. 28, Genital capsule, dorsal, view. 29, Head, pronotum, scutellum, dorsal view.

bare, oval areas (represented by stippling in Fig. 39), length 1.87, width across eyes 1.12, interocular space 0.12, antennophores not projected laterally, anteocular space to apex of antennophore 0.32, anteocular lobe to apex of head 0.87, postocular space 0.43, basal margin in contact with pronotum; eyes slightly surpassing upper margin of head, not reaching lower margin by a rostral thickness, height of eye 1.12. Antennal segments: I, 2.00; II, 2.12; III and IV missing, very short, fine, decumbent setose. Rostral segments: I, 1.50; II, 0.62; III, 0.18; glabrous. Pronotum: anterior lobe length 0.75, width 1.56, moderately setose, bigibbous, each half with 2 bare sulci; posterior lobe length 1.12, width 2.50, glabrous, smooth, posterior margin receded above



Figs. 30–44. 30–32, *Megapocaucus laticeps.* 30, Head, frontal view. 31, Hemelytron. 32, Head, pronotum, lateral view. 33, 34, *Opistoplatys* sp. 33, Head, pronotum, scutellum, dorsal view. 34, Head, pronotum, lateral view. 35–37, *Plectophorocoris gracilis.* 35, Head, pronotum, scutellum, metascutellum, dorsal view. 36, Hemelytron. 37, Head, pronotum, scutellum, lateral view. 38–41, *Tomolus costalis,* female lectotype. 38, Head, pronotum, scutellum, dorsal view. 39, Head, lateral view, genital segments, caudal. 40, Apical carina of protibia, lateral view. 41, Genital sclerites, caudal view. 42, 43, *Tribelocephala* spp. 42, *T. boschjesmana,* head, lateral. 43, *T.* sp. head, pronotum, dorsal view. 44, *Xenocaucus mancinii,* habitus.

scutellum. Scutellum triangular, width 1.37, length 1.12. Legs linear; lengths (from anterior to posterior): coxae 0.75, 0.75, 0.68, hind pair contiguous; trochanters 0.68, 0.68, 0.62; femora 2.81, 3.12, 3.93; tibiae 3.00, 2.87, 4.50, fore tibia with longitudinal keel along apical ⅓ (Fig. 40); tarsi 3-segmented, total lengths 0.12, 0.87, 0.87; claws thin, slightly thickened basally, 1.5 times thickness of tarsi. Hemelytra reaching apex of abdomen, without basal cells, width 4.00, not 2.50 as in Stål's description. Abdomen length 7.75, sparsely decumbent setose. Genital segments as in Fig. 41. Overall length 11.0.

Material examined: Female paratype described has handwritten label "Battavia, BRUMANA," in National Natuurhistorische Museum, Leiden, Nederland. The holotype most probably is the female, with very similar appearance, not as well preserved as the described paratype, 14.00 long, 5.00 mm wide, from Gunung, Singgalang, SUMATRA, also deposited in Leiden. Both have identical external genitalia.

Tribelocephala Stål 1853, 10: 263. Range—African, Oriental. 68 species. Figs. 42, 43.

Xenocaucini Maldonado
New Tribe

Xenocaucus China and Usinger 1949, 64: 43. Type of tribe. Range—Ethiopian. 2 species. Fig. 44.

Acknowledgments

This paper was made possible due to the kindness of Mrs. Janet Margerison-Knight, from The Natural History Museum, London, for the loan of *Gastrogyrus monophleboides* and *Homognetus nigripennis,* R. C. Froeschner, from the National Museum of Natural History, Washington, DC for the specimens used to describe the new genus *Abelocephala* and Pietr H. van Doesburg Jr., from the museum at Leiden, who kindly loaned me specimens of *Tomolus costalis.* Several drawings were copied from the original papers.

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DIVERSITY OF THE LEAFHOPPER (HOMOPTERA: CICADELLIDAE) FAUNA OF NORTHERN CHIHUAHUAN GRASSLANDS, WITH EMPHASIS ON GYPSUM GRASSLANDS AND DESCRIPTION OF A NEW SPECIES OF *ATHYSANELLA* (CICADELLIDAE: DELTOCEPHALINAE)

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Abstract.—Extensive areas of the northern Chihuahuan Desert of southeastern New Mexico and adjacent Texas have gypsum (gyp) outcroppings. The plant communities of these regions contain a mixture of gypsum-tolerant plants characteristic of the semiarid grasslands surrounding the gyp islands, and plants endemic to or characteristic of and attaining highest abundance in gyp areas. The insularity of the gyp formations provides an ideal situation for insect as well as plant evolution. Collections were made on 37 dominant or subdominant perennial grasses of the region. Twelve generalists and 54 specialist leafhopper species were recorded. The leafhopper diversity of the grasslands is explained by the existence of a large number of perennial grass hosts. Two of the hosts, gyp grama (*Bouteloua breviseta*) and gyp dropseed (*Sporobolus nealleyi*) account for three of the specialists, which are therefore endemic to gyp grasslands. One of these specialists is ***Athysanella* (*Athysanella*) *blockeri*, n. sp.**, taken from gyp grama, *Bouteloua breviseta,* and is described herein. Other leafhopper-grass host relationships in the New Mexico–Texas grasslands studied, on both gyp and nongyp soils, were similar to those of adjacent vegetational regions.

Key Words: Leafhopper, grassland, gypsum, ecology

Gypsum deposits, which occur in many regions of the southwestern United States and northern Mexico (Johnson 1941), are presumed to be evidence of ancient marine deposits, thought by some to date to the Permian. The exposure of these deposits may date to the mid-Tertiary, or may in some cases may be as recent as the Pleistocene (Powell and Turner 1977).

The soils of gypsum (gyp) "islands" are a powerful insularizing factor. A number of endemic plant species have arisen as gypsophiles, and indeed, some genera (e.g. *Neristyrenia*) appear to be largely gypsophilous. There is evidence for speciation of gypsophilous plants after colonization of individual gyp islands.

Knowledge of the botany of the gyp islands of trans-Pecos Texas and New Mexico (Waterfall 1946) is limited; even less is known about their insect fauna. In this paper, we describe the leafhopper (cicadellid) fauna of dominant and subdominant perennial grasses of gyp and nongyp areas of the northern Chihuahuan grasslands of southeastern New Mexico and adjacent Texas, and describe a new species of the genus *Athysanella* that is apparently endemic to gyp grasslands of this region.

METHODS

Methods for collection and identification of leafhopper specimens have been de-

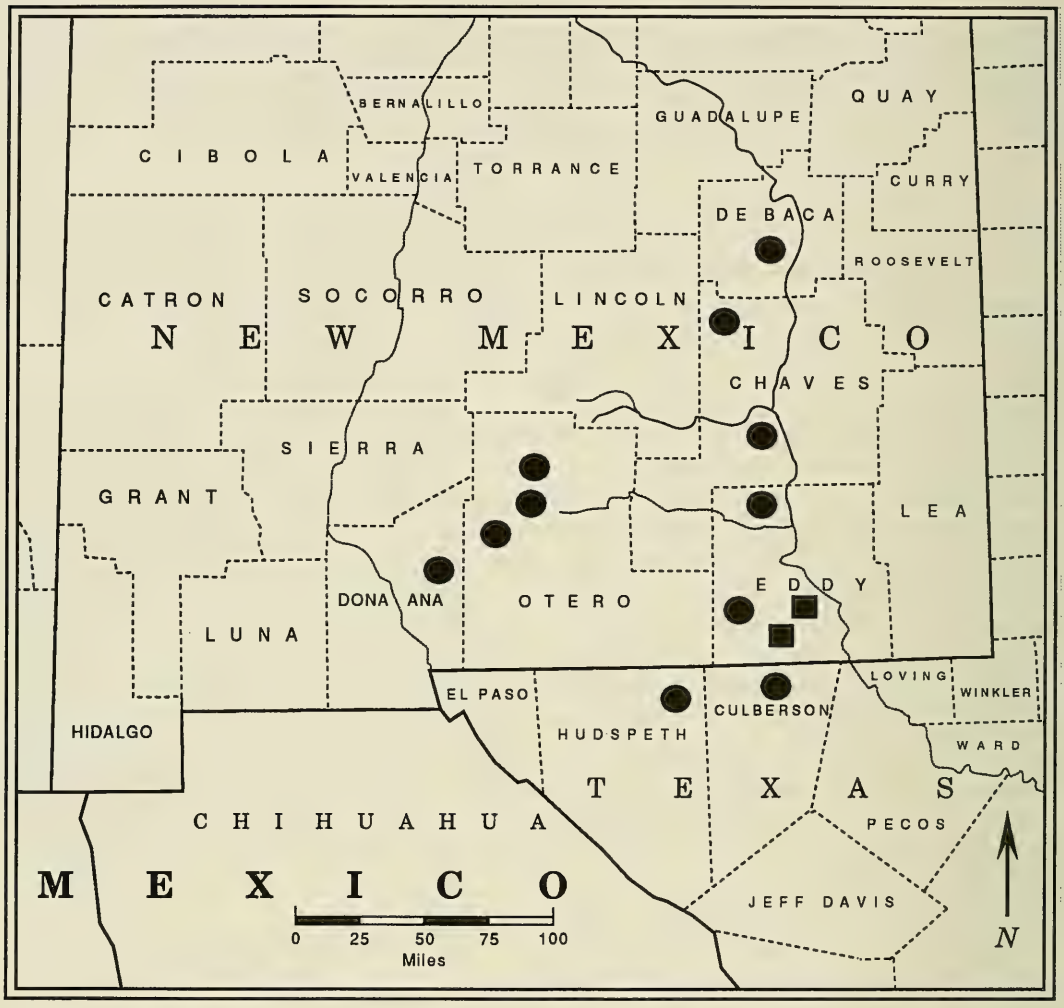

Fig. 1. Localities for collections summarized in this paper. Collections were from low elevation grasslands (3800–5400 ft). Material from higher elevations of the Sacramento and Guadalupe Mountains was not included.

scribed (Whitcomb et al. 1986, 1987). Localities (Fig. 1) of the collections described herein are drawn from a large matrix of data (Lynn and Whitcomb 1987) compiled over many years for host records of leafhoppers from North American grasslands. IBL (Insect Biocontrol Laboratory, Beltsville, Maryland) accession numbers selected for analysis in this paper are 0840–845; 0854–875; 1919–1925; 1928–1991; 2099–2115; 2176–81; 2184–85; 2193; 2196–97; 3514–3518; 3543–3558; and 3571–3580. Plant specimens were taken as vouchers for many collections. Binomial names of grass species studied are given in Appendix 1. Insect specimens, with the exception of holotypes and some paratypes, and notes on each accession, are stored in the IBL collection.

Results

Our surveys of gyp grasslands in southeastern New Mexico and adjacent Texas are summarized in Table 1. A total of 37 dominant or subdominant grass species (Appendix 1) were studied. Leafhoppers collected on these grasses could be classified as either generalists or specialists. Although the classification of each leafhopper species was

derived from these surveys, it was also consistent with previously reported surveys (Whitcomb et al. 1986, 1987, 1988) of Chihuahuan grasslands of trans-Pecos Texas such as those of the Davis Mountains, Guadalupe National Park, and Big Bend National Park.

Twelve generalist leafhopper species were collected regularly on many grass species (Table 1). These generalists were found on annual and/or exotic grasses as well as native perennials. In contrast, 54 leafhopper species were classified as specialists. The degree of specialization of these species was quantified by computing the oligophagy coefficients (Whitcomb et al. 1987, 1988) for these species, using the southeastern New Mexico-Texas data set. Seven cicadellid species occurred so infrequently that their status could not be inferred.

Three host specialists were found on gyp endemic plant species. *Athysanella blockeri* Hicks & Whitcomb is a new species and is described below. The other two gyp endemic specialists, *A.* (*Athysanella*) *stylosa* Blocker & Johnson and *A.* (*Athysanella*) *pastora* Blocker and Johnson collected in some accessions summarized here, were previously described (Blocker and Johnson 1988a). *Athysanella* (*Amphipyga*) *ladella* Johnson was found on several grass species, and may be a habitat specialist. In addition, some species adapted to grasses such as alkali sacaton (*Sporobolus airoides*) and saltgrass (*Distichlis stricta*) were common in gyp communities. Host relationships in the region were similar or identical to those of adjacent regions (Whitcomb et al. 1987, 1988), so the leafhopper composition of gyp areas could be explained entirely, or almost so, by the species composition of the gyp plant communities.

Discussion

The New Mexico and Texas grasslands studied represent essentially the northernmost extent of the Chihuahuan Desert. Almost all grass-inhabiting leafhoppers of this region could be classified readily as generalists or specialists. The classification, which was derived from the data for this region alone, was reinforced by our data base on host relationships in North American grasslands from Canada to Mexico (Whitcomb et al. 1986, 1987, 1988, 1990, Whitcomb and Hicks 1994, Hicks et al. 1988, 1990, Blocker et al. 1990). Although all leafhopper species studied (Table 1) are believed to reside largely or entirely on grasses, our records indicate that some of the species may feed on forbs in the fall or early spring when their grass hosts are unavailable. Our data document adult food hosts, but in many cases regular collection of immatures from host plants confirmed specific host plant associations.

A number of leafhopper species are associated principally or entirely with forbs. These include members of the genera *Norvellina, Texananus, Driotura, Paraphlepsius, Acinopterus, Scaphytopius,* and several genera of the Gyponinae. Although occasional specimens of these species were encountered in our surveys, we know little of their biologies. In cases where life histories of certain species of these genera have been studied, their biologies have turned out to be complex. For the biology of these species to be fully understood, each species may have to be studied idiosyncratically, on its own terms.

Most or all of the rules governing assembly of insect-grassland communities in northern Chihuahuan grasslands follow directly from those outlined in our series of publications on grass-leafhopper relationships (Whitcomb et al. 1986, 1987, 1988). Among the most important factors in the biogeographical relationships is the historical (phylogenetic) component. For example, many species of the genus *Athysanella,* especially its typical subgenus, have evolved extensively with lowland gyp/alkaline/saline habitats. This genus is therefore one of the principal component taxa enhancing diversity in northern Chihuahuan grasslands. In recent papers, we have discussed the role of phenology (Hicks et al.

Table 1. Association of cicadellid species and dominant or subdominant grasses of southeastern New Mexico lowlands.

Grass species	Generalists[1]						
	n[2]	Au	Asp	Bg	Bn	Ct	Dsp
Aristida spp.	2	3	2	0	31	0	0
Bothriochloa spp.	1	0	16	0	18	0	0
Bouteloua breviseta	10	23	7	0	77	0	0
B. curtipendula	4	0	1	0	9	0	0
B. eriopoda	3	1	3	0	1	0	0
B. gracilis	11	0	3	0	120	0	0
B. hirsuta	2	0	0	0	1	0	0
Buchloë dactyloides	11	8	1	0	13	0	0
Chloris cucullata	2	16	1	2	38	0	0
C. verticillata	1	1	0	0	4	0	0
Cynodon dactylon	1	1	0	0	15	0	0
Distichlis stricta	6	0	0	0	3	0	0
Erioneuron pilosum	2	3	1	0	8	0	0
E. pulchellum	2	4	4	0	1	0	0
Hilaria mutica	6	0	1	0	6	0	0
Leptochloa dubia	1	0	0	0	11	0	0
Muhlenbergia arenacea	7	19	19	0	16	0	0
M. arenicola	2	5	2	0	1	0	0
M. asperifolia	1	0	0	0	0	0	0
M. pauciflora	1	0	2	0	3	0	0
M. repens	3	0	0	0	0	0	0
M. setifolia	1	0	0	0	0	0	0
P. hallii	1	1	0	0	14	0	0
Panicum obtusum	3	0	1	0	2	0	1
Scleropogon brevifolius	14	14	12	0	0!	1	2
Setaria leucopila	2	9	2	0	10	0	2
Sitanion hystrix	1	0	0	0	2	0	1

Table 1. Extended.

Generalists[1]						Specialists[3]
Gs	Ee	Ei	Mq	Sb	Xsp	
0	1	0	0	0	1	*Flexamia arizonensis* (39) (0.949) *Athysanella rata* (19) (1.000)
2	33	1	0	0	0	*Flexamia prairiana* (26) (1.000) *Laevicephalus vannus* (1) (1.000)
2	3	0	0	0	1	*Athysanella blockeri* (77) (0.922) *Athysanella pastora* (49) (1.000) *Athysanella ladella* (7) (0.286)
1	0	0	0	0	0	*Laevicephalus mexicanus* (11) (1.000) *Laevicephalus opalinus* (6) (1.000) *Laevicephalus minimus* *Laevicephalus inconditus* (10) (0.900) *Cazenus* sp. (2)
0	0	0	0	0	0	*Athysanella spatulata* (1) (1.000)
3	7	0	0	0	2	*Flexamia abbreviata* (55) (0.836) *Flexamia flexulosa* (8) (1.000) *Gillettiella labiata* (16) (1.000) *Athysanella sinuata* (14) (1.000) *Athysanella argenteola* (7) (0.778)
0	0	0	0	0	0	*Laevicephalus exiguus* (5) (1.000) *Athysanella nigriventralis* (3) (1.000) *Polyamia* sp. (2) (1.000)
10	7	0	0	0	0	*Flexamia curvata* (31) (1.000) *Polyamia satur* (7) (1.000) *Laevicephalus parvulus* (59) (1.000) *Athysanella emarginata* (226) (0.991) *Gillettiella atropunctata* (148) (0.943)
1	30	0	0	0	0	none
0	5	0	0	0	0	none
8	0	1	0	0	0	*Balclutha incisa* (1)
3	2	0	0	0	0	*Lonatura salsura* (40) (1.000) *Memnonia* sp. (17) (1.000) *Athysanella incerta* (279) (1.000)
0	0	0	0	0	0	*Memnonia* sp. (3)
0	0	0	0	0	0	*Athysanella triodana* (1) (1.000)
0	4	0	0	0	0	*Athysanella uncinata* (137) (1.000) *Athysanella sagittata* (17) (1.000) *Peconus scriptanus* (3) (1.000) *Hecullus* sp. (22)
3	2	0	0	0	0	none
0	11	0	0	0	0	*Flexarida chaotica* (18) (1.000) *Athysanella arcana* (491) (0.197)
0	0	0	0	0	0	none
0	0	0	0	0	0	*Flexamia inflata* (51) (1.000)
1	0	0	0	0	0	*Flexamia mescalero* (29) (1.000)
0	0	0	0	0	0	*Flexamia modica* (10) (1.000) *Deltocephalus minutus* (25) (1.000)
0	0	0	0	0	0	*Telusus blandus* (2)
0	0	0	0	0	0	none
1	26	0	0	1	0	*Polyamia neoyavapai* (33) (0.818)
0	8	0	0	0	7	*Athysanella arcana* (491) (0.786) *Decua curta* (35) (0.886)
0	15	1	1	7	1	none
0	0	0	0	0	0	none

Table 1. Continued.

Grass species	Generalists[1]						
	n[2]	Au	Asp	Br	Bn	Ct	Dsp
Sorghum halepense	0	0	2	3	0	0	0
Sporobolus airoides	8	3	0	0	102	0	3
Sporobolus cryptandrus	5	7	6	0	42	0	3
Sporobolus nealeyii	10	43	14	0	63	0	5
Sporobolus texanus	2	0	0	0	7	1	11
Sporobolus sp.	2	4	0	0	44	2	18
Stipa tenuissima	1	0	0	0	0	0	4
Trichachne californica	1	1	0	0	5	0	0
Tridens albescens	2	5	2	0	22	0	81
Tridens muticus	1	0	0	4	1	0	0

[1] Symbols for generalists: Au: *Aceratagallia uhleri*; Asp: *Aceratagallia* spp. (not *uhleri*); Br: *Balclutha rosea*; Bn: *Balclutha neglecta*; Ct: *Circulifer tenellus*; Dsp: *Draculacephala* sp.; Gs: *Graminella sonorus*; Ee: *Exitianus exitiosus*; Ei: *Endria inimica*; Mq: *Macrosteles quadrilineatus*; Sb: *Stirellus bicolor*; Xsp: *Xerophloea* spp. (*X. peltata* and *X. robusta*). The current status of taxonomy of *Aceratagallia* did not permit naming of species other than *A. uhleri.*

[2] n = number of collections in region.

[3] Data for specialists is in the form: species [number of individuals] [oligophagy coefficient (Whitcomb et al. 1987, 1988) for given plant species]. Oligophagy coefficients were computed for species whose numbers in our overall surveys (Lynn and Whitcomb 1987) justified their assignment as specialists. Where insufficient data were available to classify a species as a generalist or specialist, no oligophagy coefficients were computed. In several cases, specialists are listed which occur in regions very close to the sampled region, but that did not occur in our samples. The present status of taxonomy of Hecalinae (*Dicyphonia, Hecullus, Hecalus*) did not permit assignment of species names.

1988, Whitcomb and Hicks 1994) and taxonomic idiosyncracy (Hicks et al. 1992, Whitcomb and Hicks 1994) in the determination of biotic diversity.

We now briefly discuss certain host associations of the northern Chihuahuan grasslands that are of special interest:

The Laevicephalus-sideoats grama association. Southeastern New Mexico is a meeting place for four *Bouteloua* leafhopper specialists of the genus *Laevicephalus.* All are members of the "minima" clade of Ross and Hamilton (1972). *Laevicephalus inconditus* Knull is largely Chihuahuan in distribution, and occurs exclusively on sideoats grama (*Bouteloua curtipendula*) at low elevation. *Laevicephalus opalinus* Ross and Hamilton also occurs on side-oats grama in low to medium altitude grasslands; to the west of this region, this species occurs on blue grama also (Hicks and Whitcomb 1992). *Laevicephalus minimus* (Osborn and Ball) occurs on blue grama at higher elevations in the Sacramento Mountains and Colorado Rockies, but is largely a prairie species, where it specializes on sideoats grama east to Maryland (Hicks and Whitcomb 1992). Finally, *L. mexicanus* (Ross and Hamilton), known before our studies only from Mexico, was collected once at

Table 1. Extended. Continued.

Generalists[1]						Specialists[3]
Gs	Ee	Ei	Mq	Sb	Xsp	
0	0	0	1	1	0	none
0	4	0	0	0	1	*Unoka ornata* (39) (0.231) *Athysanella truncata* (78) (1.000) *Athysanella callida* *Athysanella kanabana* (17) (1.000) *Athysanella blanda* (8) (1.000) *Dicyphonia* sp. (6) *Hecullus* sp. (51)
1	22	2	0	0	4	*Dicyphonia* sp. (1) *Hecullus* sp. (1) *Athysanella curtipennis* (15) (1.000) *Unoka ornata* (39) (0.077)
0	1	0	0	0	0	*Athysanella stylosa* (118) (1.000) *Athysanella ladella* (5) (0.714) *Unoka ornata* (39) (0.077)
0	1	0	0	0	0	*Balclutha incisa* (3)
0	2	2	0	1	1	*Dicyphonia* sp. (2) *Athysanella curtipennis* (15) (1.000)
0	0	1	0	0	0	*Dikraneura* sp. (19)
0	3	0	0	0	0	none
1	1	0	0	0	0	none
0	0	0	0	0	0	none

Roswell. The uneven distribution of these species in northern Chihuahuan grasslands suggests that all may be at the edge of their ranges, where they may be extirpated in years when climate may be unfavorable. *Laevicephalus mexicanus* may be only one of many leafhopper species that are common south of the border, but that persist at more northerly latitudes in the absence of killing freezes.

Flexamia species. Although the genus *Flexamia* is primarily adapted to prairie or mesic grasslands, eight species occur in northern Chihuahuan grasslands, where each specializes on a specific host. Several of these hosts are *Muhlenbergia* species. For example, *Flexamia mescalero* Whitcomb and Hicks was found at only a single location on *Muhlenbergia pauciflora* growing on a moist slope. Although *F. mescalero* may occur in Mexico, extensive collecting in other locations on its apparent host in the United States has revealed no further populations. Because its host is relatively limited in distribution and abundance, *F. mescalero* should be tentatively considered to be threatened, and its habitat protected. A second seldom-collected Chihuahuan species, *F. zacate,* occurs on its host, *Muhlenbergia porteri,* in Otero County, New Mexico, and El Paso County, Texas. Otherwise, this species is known only from Big Bend National Park, in trans-Pecos Texas. Another infrequently collected species, *F. modica* (Beamer and Tuthill), is a specialist of *Muhlenbergia repens* at elevations above about 5400 ft throughout much of southern New Mexico. In saline wetlands, *Flexamia inflata* occurs on *Muhlenbergia asperifolia.*

Although two specialists of blue grama, *F. abbreviata* (Osborn and Ball) and *F. flexulosa* (Ball) occur in the region, one (*F. flexulosa*) is understood best in terms of the differential phylogenetic origin of the two species (Whitcomb and Hicks 1994). *Flexomia flexulosa* diverged from a clade (Whitcomb and Hicks 1988) that probably

originated in northern grasslands. On the other hand, *F. abbreviata* reached the blue grama grasslands of New Mexico by a diametrically opposite route: i.e. through the mixed *Bouteloua* grasslands of the Chihuahuan Desert. It is not surprising, therefore, that in this area, as in Chihuahuan grasslands to the south, blue grama is colonized almost exclusively by *F. abbreviata.* This relationship is confirmed by the reciprocal observation that the blue grama grasslands of the Colorado Plateau are colonized almost exclusively by *F. flexulosa.*

Athysanella species. Most *Athysanella* species in this region, including the endemics, occupied their usual host. Two relationships in the region, those of *Athysanella* (*Diphypyga*) *triodana* Ball and Beamer with *Dasyochloa pulchella,* and of *A.* (*Pedumella*) *spatulata* Ball and Beamer with black grama, *Bouteloua eriopoda* may be very old. These leafhopper species were placed in primitive clades by Blocker and Johnson (1988a). It is possible that these relationships may date to early or even pre-Pleistocene times when the host grasses, both able to colonize bare rocky slopes, may have been more common than they are today.

A collection from galleta (*Hilaria jamesii*) in the northernmost portion of the Chihuahuan grasslands represents the sole record of *Athysanella* (*Gladionura*) *uncinata* Ball and Beamer on this host. The usual host for *A. uncinata* is a close congener of tobosa (*Hilaria mutica*). Because these grass species are almost completely allopatric in New Mexico (K. Allred, personal communication), the factors governing host relationships could have been confounded. We believe this collection demonstrates that *A. uncinata* is able to feed on galleta in a climatic regime compatible with the life history strategy of the leafhopper specialist. Indeed, experimental data (Whitcomb et al. 1986) have shown that most leafhopper species tested, including some apparently strict specialists, had much broader experimental host ranges than field observations had suggested. We therefore believe that the four specialists of *Hilaria mutica* and the six specialists of galleta (see Table 1) are most likely confined to their ranges by adaptations to the idiosyncrasies of local climate, rather than by nutritional or other association with the closely related *Hilaria* species.

Burrograss. We noted three striking features of the assemblage of leafhoppers on burrograss (*Scleropogon brevifolius*). One is the only example [*Decua curta* (Beamer)] from our grassland studies that suggest host specificity exists in the xylem-feeding subfamily Cicadellinae. The second is the extremely high numerical abundance of the specialist *Athysanella* (*G.*) *arcana* Ball and Beamer. This species was the most abundant of all specialists we encountered in the region. Collection data suggesting that it may also occur on *Muhlenbergia arenacea* may be misleading, since burrograss almost universally occurs with *M. arenacea* in saline/alkaline flats. The third unusual feature that emerged (Table 1) is the complete absence of the commonest and most widespread supertramp of the region, *Balclutha neglecta* (Delong and Davidson), from 14 collections on burrograss.

Diversity. Because we have elucidated (Whitcomb et al. 1986, 1987, 1988, Whitcomb and Hicks 1994) the brickwork of North American grass-leafhopper host relations, a reasonable interpretation of leafhopper diversity in the grasslands of southeastern New Mexico can be constructed. Cicadellid diversity is seen to be a direct consequence of the regional distribution of dominant, perennial grass hosts. Presumably, forb diversity makes a similar contribution in its provision for ovipositional and food hosts for forb generalists and specialists.

Comparison of specializations within the region studied reveals no case of a specialization that is different within the region than in an adjacent region. In the northern Chihuahuan grasslands, as in other regions, however, species at the limit of their ranges

may be more restrictive specialists than in portions of their range where they are more abundant. This is especially true of southern species at the northern limits of their ranges (Whitcomb et al. 1987).

Leafhopper host specificities identified in this study are in excellent agreement with generalizations for insect host specialists (Strong 1979), and leafhopper grass specialists in particular (Whitcomb et al. 1987), that the number of specialists associated with a given host is a function of its dominance over evolutionary and (especially) contemporary time. Thus, dominant hosts such as buffalograss, blue grama, side-oats grama, saltgrass, tobosa and alkali sacaton have large specialist assemblages. Less common grasses such as burrograss and *Dasyochloa pulchella* have smaller assemblages of associated specialists, and even less common grasses such as *Leptochloa* or *Tridens* species appear to have no associated specialists. In this context, the species richness of *Athysanella* species associated with two gypsophilic grasses, gyp grama (*Bouteloua breviseta*) and gyp dropseed (*Sporobolus nealleyii*), is rather remarkable. Both grasses are reasonably common in gyp areas of New Mexico, but the total global biomass of these grass species is low, especially when compared with abundant New Mexico grasses such as blue grama or side-oats grama. Regional, rather than global abundance is therefore sufficient to promote speciation. Three *Athysanella* species are associated with gyp grama. These are *A. pastora, A. blockeri* n. sp. (described herein) and *A. ladella.* The latter species, collected only in gyp, saline or alkaline habitats, may be shared with gyp dropseed and/or other grasses that tolerate the harsh edaphic conditions of desert lowlands. Gyp dropseed also harbors an apparent specialist, *A. stylosa.* The current regional biomass of gyp dropseed is substantially less than that of gyp grama. One leafhopper species (*Unoka ornata* Osborn), although clearly a specialist on *Sporobolus* species, is found in northern Chihuahuan grasslands not only on gyp dropseed, a grass with very low (often about 10–12 cm) growth form and very patchy local occurrence, but also on a larger *Sporobolus* species (sand dropseed, *Sporobolus cryptandrus*). It also occurs on the much larger alkali sacaton (*Sporobolus airoides*), which can reach 3 m in height, and which often occurs in dense stands. The latter grass, a common inhabitant of wet alkaline and/or saline bottoms throughout southwestern deserts, has a very rich leafhopper fauna of its own.

Insects and gyp regions. We have discussed herein the leafhopper fauna of a small fraction of the gyp formations of the American Southwest and Mexico. The recent discovery of three new species of leafhoppers (*A. blockeri, A. pastora,* and *A. stylosa*) in this single small region suggests that other new and interesting species doubtlessly remain to be discovered.

For gypsophilous species, the gypsum outcroppings represent true "islands," isolated edaphically as well as spatially from other suitable habitat. This insularity has resulted in considerable speciation among plant gypsophiles. The brachyptery of *Athysanella* species suggests that their evolution may be affected equally profoundly. Certainly the presence of two species of subgenus *Athysanella* on gyp grama in New Mexico suggests a complex geologic history, in which isolated populations have speciated rapidly. In this regard, the majority of *Athysanella* species are severely restricted in their geographic distribution.

Conservation significance. Clearly, the gyp, saline, and/or alkaline bottomlands of the Southwest have promoted a rich diversification of leafhoppers and, undoubtedly, other insect specialists as well. Of these formations, the gyp areas (Johnson 1941, Powell and Turner 1977, Waterfall 1946) are one of the least common and one of the richest (per unit area) in terms of endemic species. The biotic content of the areas has not been well studied, and even new plant species continue to be identified from them.

At a time when conservation biology is

turning increasingly to consideration of entire functioning ecosystems, there is a danger that requirements for conservation of species from small, edaphically unusual habitats could be overshadowed by broader plans to protect large and aesthetically attractive biotic regions.

In the case of the gyp regions of southeastern New Mexico, entire functioning ecosystems may consist of relatively small areas in lowlands that can be expected to experience increasing pressures for development. It is our belief that state Heritage programs, particularly if they are associated with initiatives to acquire and protect endangered habitats associated with unusual edaphic conditions, should scrutinize gyp areas closely to be certain that small but biotically rich habitats and ecosystems, with their associated endemic species, are not inadvertently destroyed.

Athysanella (*Athysanella*) *blockeri* Hicks and Whitcomb, New Species

Length of male 2.30 to 2.76 mm, female 3.32 to 3.96 mm; head width of male 0.95 to 1.07 mm, female 1.01 to 1.21 mm; pronotal width of male 0.87 to 0.97 mm; female 0.93 to 1.07 mm; interocular width of male 0.40 to 0.46 mm, female 0.46 to 0.57 mm; vertex length of male 0.36 to 0.44 mm, female 0.42 to 0.54 mm; pronotal length of male 0.32 to 0.38 mm, female 0.34 to 0.42 mm.

Character code: 1-1-1-1-2-1-1-0-2-0-1-0-1-0-1-1-0-0 (see Blocker and Johnson 1988).

Color tawny; vertex with fuscous spots on margin of vertex, one apical and one on each side between the apex and the eyes. Vertex, face, pronotum, abdomen, and venter with irregular brown markings. Forewings and legs often with dark brown spots.

Forewings brachypterous (Fig. 2), exposing 4.0–4.5 pregenital abdominal terga; ocellus approximately 1.0 its diameter from eye. Hind tibial spur often absent (Fig. 3G); when present (Fig. 3F), more than ¾ the length of the first tarsomere.

Male.—Pygofer (Fig. 3C) with caudal margin extended, with numerous macrosetae, not embrowned; anal tube attaining apex of pygofer; valve rounded on apical margin; plates truncate, separated basally, with a small sclerotized section on the outer caudal margin attaining ⅔ length of pygofer. Styles (Fig. 3A) rectangular in broad aspect, with short lobe on lateral margin, equalling the apices of plates. Connective about ¼ to ⅕ longer than style; aedeagus (Fig. 3B) elongate with parallel-sided shaft slightly recurved, caudal margin of shaft smooth, with dorsal apodeme short, undeveloped. Aedeagus with basal process that becomes bifurcate, in caudal aspect, at about ⅓ length. The bifid process parallels the shaft, bending, in lateral view, anterodorsad toward the aedeagus with paired apical halves situated on each side of aedeagal shaft and the upper ⅓ irregularly serrate.

Female.—Sternum VII (Fig. 3E) with caudal margin produced, medial lobe slightly concave, somewhat embrowned.

Types.—*Holotype male:* NEW MEXICO: Carlsbad, 3800 ft, 9 Aug. 1984, R. F. Whitcomb, IPL 000841, deposited in the National Museum of Natural History (NMNH), Washington D. C. *Paratypes:* 29 males, 23 females, same collection data, IPL 000841 and 843; and NEW MEXICO: Whites City, 3800 ft, 27 Aug. 1985, A. L. Hicks and R. F. Whitcomb, IPL 002102 and 2103, are in NMNH; California Academy of Sciences, San Francisco; Canadian National Collection, Ottawa, Ontario; University of Kansas, Snow Museum, Lawrence; and Ohio State University, Columbus.

Athysanella (Athysanella) *blockeri* is related to *A. robusta,* to which it will key (Blocker and Johnson 1988) but can be separated from it and all other *Athysanella* species by its unique basal aedeagal process. In *robusta,* this process is not bifid apically, and does not bend toward the aedeagal shaft. Also, the pygofer of *A. blockeri* is not as produced as in *robusta.* We have not ob-

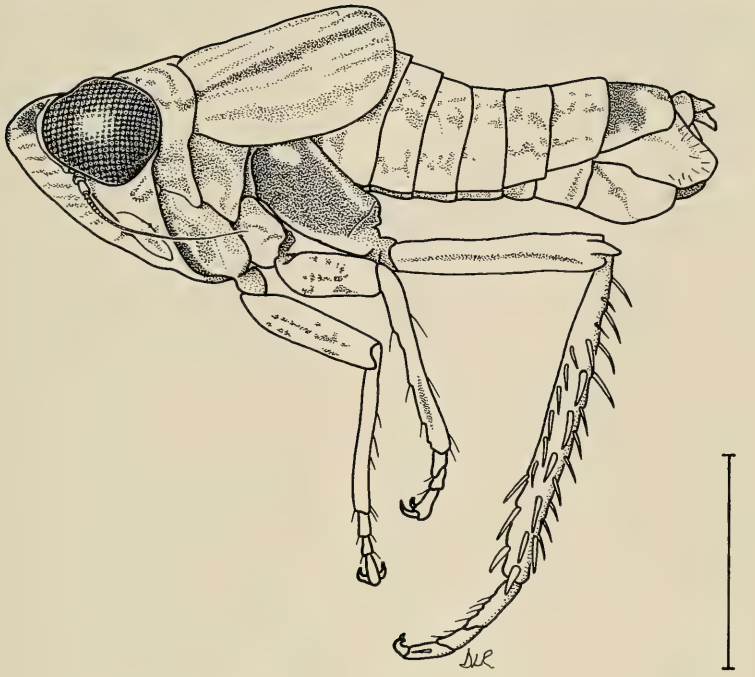

Fig. 2. *Athysanella blockeri,* habitus.

served undeveloped or parasitized individuals, or long-winged forms.

It is important to note that the hind tibial spur is missing or greatly reduced in many specimens of *A. blockeri.* Such a specimen would incorrectly key to subgenus *Amphipyga* (Blocker and Johnson 1990). However, because this species has been collected only in gyp localities in southeastern New Mexico, and is quite distinct, aberrant specimens

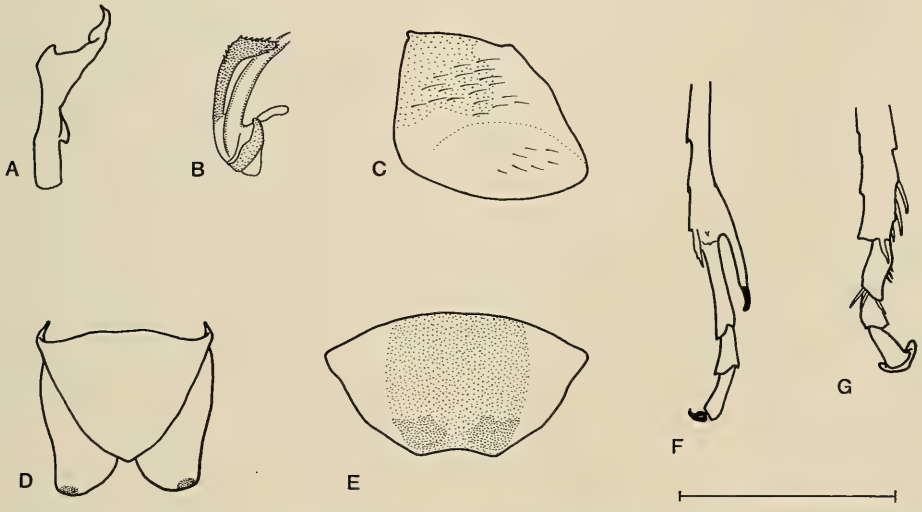

Fig. 3. *Athysanella blockeri.* A, Style, ventral aspect. B, Aedeagus, lateral aspect. C, Male pygofer, lateral aspect. D, Male plates and valve, ventral aspect. E, Female sternum VII, ventral aspect. F, Hind tarsi and tibial spur. G, Hind tarsi; tibial spur missing.

should be easily recognizable. The only known host is gyp grama, *Bouteloua breviseta* Vasey.

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Appendix

Scientific and common names of grass species studied.

Aristida spp., three awn grasses; *Bouteloua breviseta* Vasey, gyp grama; *Bouteloua curtipendula* (Michx.) Torr., side-oats grama; *Bouteloua eriopoda* (Torr.) Torr., black grama; *Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths, blue grama: *Bouteloua hirsuta* Lag., hairy grama; *Buchloë dactyloides* (Nutt.) Engelm.; buffalograss; bermudagrass; *Chloris cucullata* Bisch., hooded windmillgrass; *Chloris verticillata* Nutt., windmillgrass; *Cynodon dactylon* (L.) Pers.; *Distichlis stricta* (L.) Greene, salt grass; *Erioneuron pilosum* Buckl. Nash, hairy tridens; *Dasyochloa pulchella* (Kunth) Rydb. (= Erioneuron pulchellum), fluffgrass; *Hilaria jamesii* (Torr.) Benth., galleta; *Hilaria mutica* (Buckl.) Benth., tobosa; *Leptochloa dubia* (Kunth) Nees, green sprangletop; *Muhlenbergia arenacea* (Buckl.) Hitchc., ear muhly; *Muhlenbergia arenicola* Buckl., sand muhly; *Muhlenbergia asperifolia* (Nees. Mey.) Parodi, scratchgrass; *Muhlenbergia pauciflora* Buckl., New Mexico muhly; *Muhlenbergia porteri* Scribn. *ex* Beal, bush muhly; *Muhlenbergia repens* (Presl) Hitchc., creeping muhly; *Muhlenbergia setifolia* Vasey, curly leaf muhly; *Panicum hallii* Vasey, Hall's panicum; *Panicum obtusum* Kunth, vine mesquite; *Scleropogon brevifolius* Phil., burrograss; *Setaria leucopila* (Scribn. & Merr.) K. Schum., plains bristletail; *Sitanion hystrix* (Nutt.) Sm., squirreltail; *Sorghum halepense* (L.) Pers., johnsongrass; *Sporobolus airoides* (Torr.) Torr., alkali sacaton; *Sporobolus cryptandrus* (Torr.) Gray, sand dropseed; *Sporobolus nealleyi,* Vasey, gyp dropseed; *Sporobolus texanus* Vasey, Texas dropseed; *Stipa tenuissima* Trin., finestem needlegrass; *Trichachne californica* (Benth.) Chase, cottontop; *Tridens albescens* (Vasey) Woot. & Standl., white tridens; *Tridens muticus* (Torr.) Nash, slim tridens.

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XENOTHYRINI, A NEW TRIBE OF LABENINAE, AND A KEY TO THE TRIBES AND GENERA OF LABENINAE (HYMENOPTERA: ICHNEUMONIDAE)

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Abstract.—A new tribe, **Xenothyrini,** is proposed for the labenine genus *Xenothyris.* A worldwide key to labenine genera is provided.

Key Words: Hymenoptera, Ichneumonidae, Labeninae, Xenothyrini, *Xenothyris*

In a recent cladistic analysis of the genera of Labeninae (Wahl 1993b), I pointed out that the monotypic genus *Xenothyris,* based on its position relative to the other tribes in the subfamily, should be placed in its own tribe. Although I took no action on the matter at the time, I am now erecting a new tribe, Xenothyrini, in order to maintain a natural classification. I am also providing a new key to the genera of Labeninae, as there has been extensive redefinition of the tribes and genera (Gauld 1983, 1984, Gauld and Holloway 1986, Porter 1989, Wahl 1993b) since the publication of the last comprehensive key (Townes 1969).

The morphological terminology is that of Wahl (1993a), except for *hypostomal-mandibular index:* the length of the hypostomal carina from its juncture with the occipital carina to the mandibular base, divided by the basal width of the mandible. Wing veins and cells used in the text are illustrated in Fig. 1.

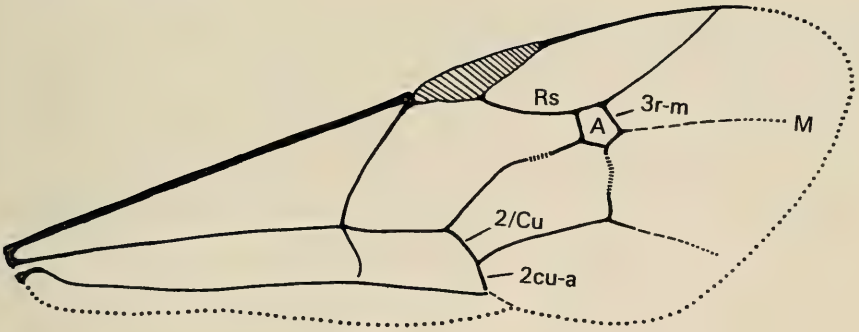
Xenothyrini, New Tribe

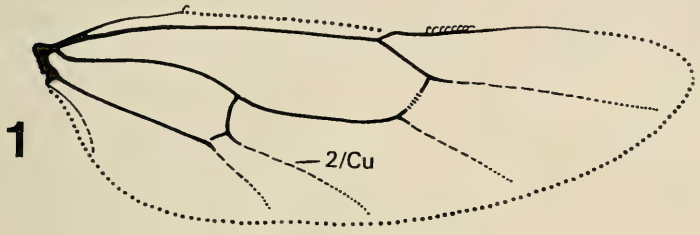
Diagnosis (autapomorphies (from Wahl 1993b) marked with an asterisk): *Supraclypeal area with prominent median convexity; labrum mostly concealed by clypeus; mandible not twisted or strongly narrowed apically; occipital carina complete dorsally; mesoscutum without transverse rugae; *posterior face of hind coxa with median slanted groove, groove not basal and vertical, or extending ventrally on a process; apex of fore tibia with dorsal tooth; *hind tarsal claw with basal tooth; metapleural carina not expanded into flange or sharp tooth; propodeal spiracle long and elliptical; insertion of metasoma on propodeum slightly above level of hind coxa; *cell 1 + 2Rs ("areolet") of fore wing about 6× as wide as high; vein 2m-cu of fore wing with two bullae; fore wing with vein 2/Cu about 1.2× as long as vein 2cu-a; hind wing with one basal hamulus; *spiracle of metasomal segment 1 near apex; *tergosternal suture of metasomal segment 1 obsolescent; *ovipositor much longer than body, approximately 11× as long as hind femur (ratio uncertain due to distortion of ovipositor); ventral margin of ovipositor apex with simple, widely-spaced teeth.

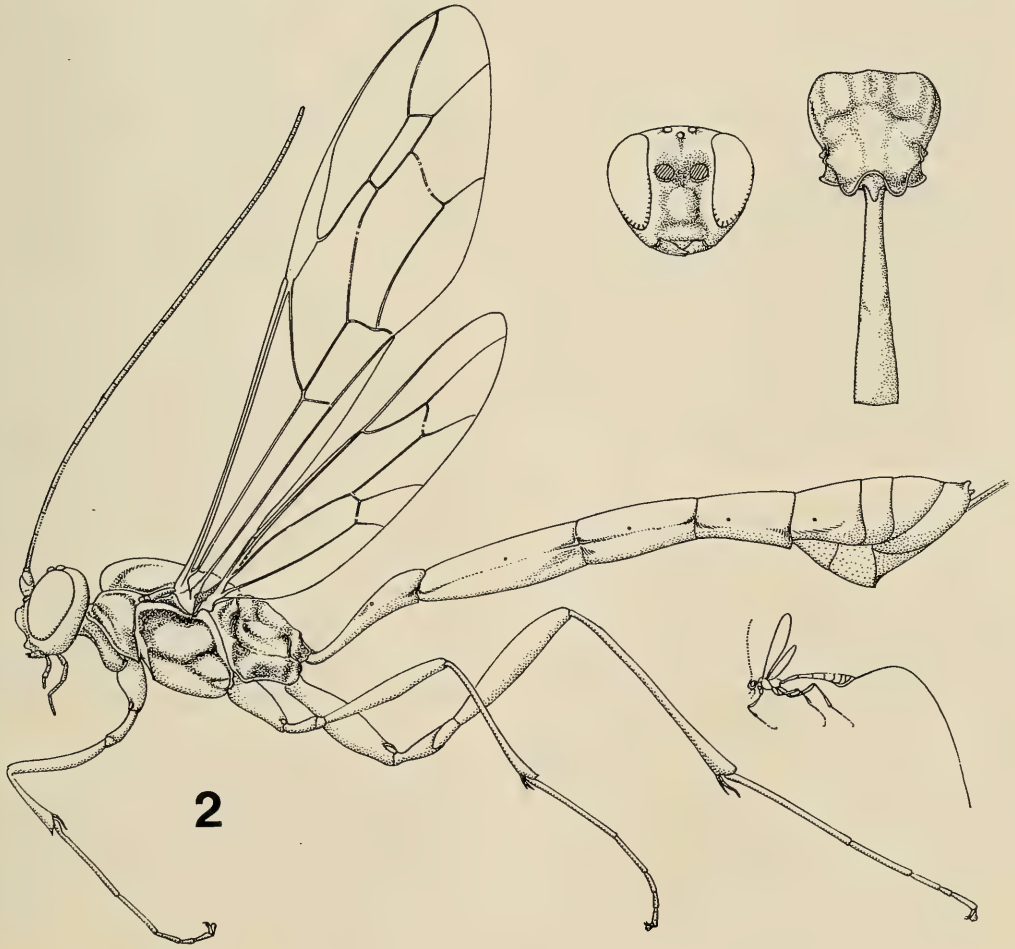
Type-genus: *Xenothyris* Townes, 1969: 197.

Species and distribution: There is a single species, *X. ferruginea* Townes, 1969 (Fig. 2), recorded from Argentina and Brazil.

Discussion: Higher-level relationships amongst the Labeninae are: Poecilocryptini + (*Xenothyris* + Groteini + Labenini)







Figs. 1–3. 1, Fore and hind wings of an ichneumonid (from Townes 1969); A - cell 1 + 2Rs. 2, Habitus of *Xenothyris ferruginea* (from Townes 1969). 3, Middle tarsus of *Labena grallator* (Say).

(Wahl 1993b). The three tribes recognized to date are each monophyletic (Wahl 1993b).

Key to the Genera of Labeninae

1. Cell 1 + 2Rs of fore wing about 6× as wide as long (fig. 2); hind tarsal claw with basal tooth; supraclypeal area with prominent median convexity (fig. 2); distribution: Argentina and Brazil. . . . . .(XENOTHYRINI) *Xenothyris*
– Cell 1 + 2Rs 1–2× as wide as high; hind tarsal claw without basal tooth or with only basal lobe (*Urancyla*); supraclypeal area without prominent median convexity. 2
2. Labrum exposed and large; hind wing with 4–8 basal hamuli in close cluster . . (GROTEINI) 3
– Labrum largely or entirely concealed by clypeus; hind wing with one basal hamulus 4
3. Metasomal segment 1 apically decurved, its spiracle near apical 0.4; hypostomal-mandibular index = 1.5–2.5; ovipositor projecting beyond metasomal apex by 1–3× length of hind femur, not dorsoventrally flattened; vein 2m-cu of fore wing with two bullae; distribution: New World. . . . . *Grotea* (including *Echthropsis* and *Macrogrotea*)
– Metasomal segment 1 straight or upcurved apically, its spiracle just before midpoint; hypostomal-mandibular index ≤ 0.5; ovipositor not projecting beyond metasomal apex, dorsoventrally flattened; vein 2m-cu with one bulla; distribution: Australian Region and Brazil. . . .*Labium*
4. Hind coxa of female with deep vertical groove at base of posterior face, sometimes extending ventrally on process; fore wing with vein 2/Cu > vein 2cu-a (except in some New World species with transverse mesoscutal rugae). . . . . .(LABENINI) 5
– Hind coxa of female without groove or process on hind coxa; fore wing with vein 2/Cu ≤ vein 2cu-a . . . . . .(POECILOCRYPTINI) 6
5. Mesoscutum with transverse rugae; metapleural carina strongly expanded into flange or sharp tooth; apical flagellomere of ♀ terminally convex; tarsomere 3 of ♀ ventrally without apical process; distribution: Australian and Neotropical Regions. . . . . *Certonotus* (including *Apechoneura* and *Asperellus*)
– Mesoscutum without transverse rugae; metapleural carina usually simple, rarely expanded into flange; apical flagellomere of ♀ terminating in flat glabrous sensilla; tarsomere 3 of ♀ ventrally with apical process (Fig. 3); distribution: Australian Region and New World. . . . . *Labena*
6. Median longitudinal carina of propodeum complete; vein 2/Cu of hind wing absent; distribution: Australian Region. . . . . *Poecilocryptus*
– Median longitudinal carina absent, at least between basal and apical transverse carinae; vein 2/Cu present or absent. 7
7. Basal transverse carina of propodeum present; vein 3r-m of fore wing present; ovipositor about 1.7× as long as hind tibia; distribution: Australian Region. . . . . *Urancyla*
– Basal transverse carina absent; vein Rs and M of fore wing fused, cell 1 + 2Rs absent; ovipositor ≥ 6× as long as hind tibia; distribution: Australian Region. . . . . *Alaothyris*

Summary of Recent Changes in Labenine Classification

Townes (1969) recognized four tribes: Brachycyrtini, Clasini, Labiini (correctly known as Groteini), Labenini. In his cladistic analysis of labenine genera, Gauld (1983) transferred the Clasini to the Cryptinae and removed *Poecilocryptus* from the Brachycyrtini to its own tribe, Poecilocryptini. Gauld (1984) next described two new genera, *Alaothyris* and *Urancyla,* in the Poecilocryptini, and one new genus, *Monganella,* in the Brachycyrtini. Gauld and Holloway (1986) synonymized *Asperellus* with *Certonotus* in the Labenini. In the Groteini, *Echthropsis* was elevated by Porter (1989) from a synonym of *Macrogrotea.* Wahl (1993b) re-examined the cladistics of the subfamily and: 1) removed the Brachycyrtini from the subfamily, 2) in Groteini synonymized *Echthropsis* and *Macrogrotea* with *Grotea,* and 3) in Labenini synonymized *Apechoneura* with *Certonotus.*

Acknowledgments

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NOTE

The Identity of *Doryctobracon tucumanus* (Blanchard) (Hymenoptera, Braconidae: Opiinae)

The purpose of this note is to clarify the status of *Doryctobracon tucumanus.* Blanchard (1966. Revista de Investigaciones Agropecuarias, Instituto Nacional de Tecnología Agropecuaria, Buenos Aires, Serie 5, Patología Vegetal 3: 21–25) described two new species of opiine parasitoids of *Anastrepha* (Tephritidae) from Argentina, placing both in the braconid genus *Opius* Wesmael. The descriptions of *O. tucumanus* Blanchard and *O. turicai* Blanchard were based on material sent to Blanchard by Antonio Turica. Unfortunately, a publication on tephritids and their natural enemies by Turica and Mallo (1961. IDIA Suplemento 6: 145–161) appeared before Blanchard's descriptions, but contained Blanchard's manuscript names (thereby creating nomina nuda). The situation was further complicated when the names appeared in a catalog of the parasitic Hymenoptera of Argentina (DeSantis. 1967. Publicación de la Comisión de Investigaciones Científicas de la Provincia de Buenos Aires. La Plata. 337 pp.), with authorship of *tucumanus* tentatively attributed to Mallo and Turica. Fischer (1977. Das Tierreich 96: 1–1001) and Wharton and Marsh (1978. Journal of the Washington Academy of Sciences 68: 147–167) transferred *tucumanus* to *Doryctobracon* Enderlein, but also mistakenly attributed authorship to Turica and Mallo, the latter citing Blanchard's work as a redescription. These and associated problems with the identification of *D. tucumanus* were recently uncovered by the senior author while working on parasitoids of Tephritidae in the area around Tucumán, Argentina.

Turica and Mallo clearly attributed authorship to Blanchard (in litteris) throughout their work. Their work is not taxonomic in nature, and these authors clearly did not intend to present a description of either of the opiine species. Although Turica and Mallo include a photograph and a one-sentence description of *Opius tucumanus,* neither, when critically examined, is sufficient to meet criteria for validation of the name *tucumanus.* The description given by Turica and Mallo (1961, p. 149) is clearly stated to apply to both *tucumanus* and *turicai.* Thus, Article 13(a)(i) (International Code of Zoological Nomenclature, Third edition. 1985. University of California Press, Berkeley) is not satisfied, since a scientific name, in order to be valid, "must be accompanied by a description or definition that states in words characters that are purported to differentiate the taxon." The valid name of this species is therefore *Doryctobracon tucumanus* (Blanchard, 1966).

Wharton and Marsh included *D. tucumanus* in a key to opiine species reared from tephritids. They were unable to locate the type material at that time, and based their characterization on the description by Blanchard and the figure in the paper by Turica and Mallo. The type material of *Opius tucumanus* Blanchard was kindly located for us in the collection of the Museo de Ciencias Naturales "Bernardino Rivadavia" in Buenos Aires by Dr. Axel Bachmann. The type series was examined by the senior author, who checked the labels carefully to determine that this was indeed the material on which the original description was based. He also compared the type series to specimens collected more recently from the vicinity of the type locality. Two syntype females were then sent to the junior author, who compared them with specimens of *Doryctobracon* collected from other parts of Latin America, and confirmed their identity.

Wharton and Marsh misread Blanchard's description and stated that the fore and middle tibiae and femora were dark brown to black. Blanchard, however, correctly noted that only the hind legs were darkened. The type material of *D. tucumanus* thus runs directly to *Doryctobracon areolatus* (Szépligeti, 1911. Bolletino del Laboratorio di Zoologia Generale e Agraria, Portici 5: 285-286) in the key included in the publication by Wharton and Marsh. Comparison of the syntype females with specimens of *D. areolatus* collected in Mexico, Costa Rica, Brazil, and Argentina shows that *D. tucumanus* (Blanchard) is a junior subjective synonym of the widespread *Anastrepha* parasitoid *D. areolatus* (Szépligeti) (**new synonym**). *Doryctobracon areolatus* is most readily recognized by the following combination of characters: propodeum areolate; head and fore and middle coxae, femora, and tibiae yellow to yellow-orange; meso- and metasoma generally yellow to yellow-orange, though mesoscutum often darker, and apical abdominal terga frequently darkened, especially in males; wings varying from hyaline to slightly dusky, never banded or with pale spots; hind tibia dark at least apically and basally, and nearly always with a distinct pale band medially. More complete descriptions of the known species of *Doryctobracon* are provided by Fischer (1977; 1980. Polskie Pismo Entomologiczne 50: 215–269).

To further clarify the status of *D. tucumanus,* we herein designate a lectotype from Blanchard's syntype series in the Museo de Ciencias Naturales "Bernardino Rivadavia." The lectotype female bears the following labels: 1) Loreto Mis. XI-58 A Turica 1. [handwritten in blue ink with the following additional data on the reverse side:] exAnastrepha s/ubajay 2) Col E. E. Blanchard [printed in black ink] 3) Ms. Arg. Cs. Nat. [printed in black ink] 4) ejemplar perteneciente a la serie tipica A. Roig A. 1993 [handwritten in black ink on pink paper] 5) LECTOTYPE Opius tucumanus Blanchard, 1966 det. Wharton 1994 [handwritten in black ink on red label]

We are especially grateful to Dr. Axel Bachmann for locating Blanchard's type material, and for comments on the publication by Turica and Mallo. We also thank Dr. Roberto Zucchi for assistance with specimens.

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NOTE

Amblyomma quadricavum (Schulze) (new combination), and *Amblyomma arianae* Keirans and Garris, a new junior synonym of *Amblyomma quadricavum* (Acari: Ixodidae)

Aponomma quadricavum was described by Schulze (1941, Zoologischer Anzeiger 133: 227) based on a female collected from *Epicrates striatus* in Haiti, July 1936, P. Thumb leg. In the title of the paper, Schulze stated that the new *Aponomma* had remnants of eyes. Later (pg. 227), he went on to state (translation), "Two narrow, oval, lighter spots near the lateral margin certainly represent remnants of eyes." Despite this, Schulze thought the tick belonged in the genus *Aponomma* because of the small size of the body, the breadth of the scutum and the shortness of the legs. He admitted (pg. 228) that "Whoever wishes to place the species in *Amblyomma,* may safely do so. . . ."

Santos Dias (1958a, Memórias e Estudos do Museu Zoológico da Universidade de Coimbra (250): 15p; 1958b, Memórias e Estudos do Museu Zoológico da Universidade de Coimbra (253): 32p.) examined 2 females (although Schulze only mentioned a holotype female) of the type material in the Hamburg Museum and considered them to be true specimens of *Aponomma quadricavum.* Santos Dias (1993, Estudos, Ensaios e Documentos (157): 204p.) continued to hold that view in his recent revision of the genus *Aponomma.* Černý (1966, Poeyana Series A (26): 10p.) agreed with Santos Dias and described the male of *Aponomma quadricavum.* However, Morel (1967, Acarologia 9: 341–352) was of the opinion that the species might actually be *Amblyomma albopictum.* Kaufman (1972, *A revision of the genus Aponomma Neumann, 1899 (Acarina: Ixodidae).* Unpubl. Ph.D. Thesis, University of Maryland. 389p.) listed it as an uncertain species of *Aponomma,* and Anderson et al. (1981, Journal of Medical Entomology 18: 123–125), considered it to be a valid *Aponomma* species and described the larva of *A. quadricavum.*

We have examined the holotype of *Aponomma quadricavum* and three additional collections (total = 7 females, 4 larvae) in the U.S. National Tick Collection (RML 101848, 105559, 112143) and conclude that these ticks are not a species of *Aponomma,* but belong in the genus *Amblyomma.* Thus, *Aponomma quadricavum* Schulze, 1941 = *Amblyomma quadricavum* (Schulze 1941) **new combination.**

We also conclude that *Amblyomma arianae* Keirans and Garris, 1986 (J. Med. Entomol. 23: 622), types of which are in the U.S. National Tick Collection (RML 115846, 116106, 117471), should be relegated to a junior subjective synonym of *Amblyomma quadricavum* (Schulze 1941) **new synonymy.**

Amblyomma quadricavum is known from the islands of Haiti, Cuba, Puerto Rico, and Jamaica (RML 101848, unpubl.) and has been reported from the colubrid snake species, *Alsophis cantherigerus* and *A. portoricensis,* and the boid species, *Epicrates angulifer, E. striatus,* and *E. subfavis* (RML 101848, unpubl.).

As mentioned in the original description of its junior synonym, *Amblyomma arianae, Amblyomma quadricavum* is unlike most New World snake-feeding *Amblyomma* species which are large, brightly ornamented ticks with rectangular basis capituli, well developed eyes, and two spurs on coxae II–IV. *Amblyomma quadricavum* is a small *Aponomma*-like tick, with no ornamentation, poorly developed eyes, a subtriangular capitulum, and a single spur on

coxae II–IV. This latter condition is also true of what is now the only known species of *Aponomma* in the Western Hemisphere, *Aponomma elaphense* Price, 1959, a parasite of the trans-Pecos rat snake, *Elaphe subocularis* found in New Mexico, the Big Bend area of Texas, and northern Mexico. In unpublished research by the junior author, *Ap. elaphense* and *Am. quadricavum* appear to form a fairly well supported lineage that makes up the sister lineage to the higher Metastriata.

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Book Review

Scuttle Flies: The Phoridae. R. H. L. Disney. Chapman & Hall. 1994. xii + 467 pp. $119.95 (hardcover).

The Phoridae is one of the most underappreciated groups of insects. Commonly dismissed as mere "garbage-feeders," this family actually comprises an incredibly varied and species-rich collection of scavengers, herbivores, predators and parasites. In this new book, Disney provides an excellent summary of these natural histories, as well as a guide to the literature on phorid genera, and a new key to world genera, the first since that of Schmitz (1929. *Revision der Phoriden.* F. Dümmler. Bonn & Berlin. 211pp.).

By authoritatively reviewing the scattered literature on phorid natural history, Disney has done a great service to future generations of researchers. Of the various chapters—titled Eggs, Larvae, Pupae, Development, Adults, Ecology, Identification and Methods—the chapter on larvae is of greatest interest to the general natural historian. The organization of this chapter is by the medium, prey, or host of the phorid species; for example, when we look for parasitoids of the argentine ant, *Linepithema humile,* we find listings for *Apocephalus silvestrii* and *Pseudacteon pusillus.* I found many listings of which I was previously unaware, including some new ones introduced by Disney. The author states in the Preface that he probably overlooked some important references, but there are few that I can add. Other useful parts of the natural history chapters include lists of egg batch size for various species, a huge section on the fungus species that are used by mycophagous phorid species, flower-visiting records and commensal relationships of phorids with social insects.

The most useful parts of the book for the working systematist are the new key to genera, and the list of literature, by genus. Actually, there are two keys, one for males and one for females, which makes identification much easier. Each key is long, with 218 couplets for males and 281 couplets for females, but they seem to work well. Key character states are abundantly illustrated by almost 100 of Disney's line drawings (elsewhere in the book there are also a few scanning electron micrographs and one color plate). The lists of literature by genus includes information on the number of described species per genus and the latest keys for identification. This section also includes discussion about some of the disagreements Disney and I have over generic concepts, and presents some new synonymies with which I do not agree.

The one weakness of this book is the lack of a phylogenetic framework in which to interpret all of this biological information. Although Disney considers evolution to be "the fundamental explanatory principle and process of biology," he dismisses all attempts to interpret phorid evolution (i.e. reconstructed phylogenies) as premature. Unusual statements, such as that taking protein-rich meals by some female phorids is "an ancestral feature retained from the Nematoceran roots of the Phoridae [pg. 28–29]," reflect this viewpoint.

A further reflection of the lack of a phylogenetic framework is found in the classification on page 8. Presented as "the currently accepted classification," this is a combination of Schmitz's (1929) organization, with the addition of Disney's own tribe Megaseliini. Nowhere is it mentioned that an alternative, phylogenetic classification, supported by hypothesized synapomorphic character states, has been proposed (Brown 1992. Generic revision of Phoridae of the Nearctic Region and phylogenetic classification of Phoridae, Sciadoceridae and Ironomyiidae (Diptera: Phoridea). Mem. Entomol. Soc. Canada. 164: 1–144).

In spite of my strong objections to the lack of a phylogenetic framework, I recommend this book highly for anyone interested in the natural history of flies in general or phorids in particular. For a more complete overview of the family, the discerning reader should be sure to supplement this text heavily with the alternative ideas about classification (Brown 1992) and the debate that followed (Disney 1993. Mosaic evolution and outgroup comparisons. J. Nat. Hist. 27: 1219–1221; Brown 1995. Response to Disney. J. Nat. Hist. 29: 259–264).

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Book Review

Functional Dynamics of Phytophagous Insects. 1994. Edited by T. N. Ananthakrishnan. Science Publishers, North Lebanon, NH $79.00 (cloth).

An insect finds a plant, recognizes it as food, eats part of it, and uses what it has eaten for maintenance, growth, and reproduction. Years ago, that sentence fairly well summed up what we knew about insect-plant interactions (then a one-way interaction), except that if the plant was economically important, the insect had to die.

Now, entire books, symposia, and annual review volumes are devoted to analyzing and clarifying each of the verbs in that opening sentence, and others to "parts" and the last three nouns. Nor is the interaction seen any longer as one-way: The plant also reacts to, is influenced by, invites or repels the insect's attention; and further volumes elucidate this now two-way relationship.

Among the best of these volumes, one looking at the relationship from the insects' "point of view," is the one reviewed here. Its editor (who also edits *Phytophaga,* a journal "principally relating to insect-plant interactions") has brought together 20 authors from the United States and India, who in 11 chapters cover subjects from the role of phytochemicals in insect-plant interactions, and the importance of space (or distributions within that space) to such interactions, to carnivory in herbivorous insects.

More particularly, these topics are treated:

Geographic variation in plant allelochemicals of significance to insect herbivores (K. S. Johnson and J. M. Scriber);

Phytochemicals as messengers altering behavior (D. M. Norris);

Physiological basis of feeding and oviposition behavior in moths (S. B. Ramaswamy);

Interacting chemical stimuli mediating oviposition by Lepidoptera (J. A. Renwick and X. Huang);

Energetics and resource allocations in the lepidopteran complex infesting the cotton plant in terms of cultivar diversity and plant chemical quality (T. N. Ananthakrishnan, S. Venkatesan, and S. Sridhar);

Intra- and interplant behavioral dynamics of the cotton bollworm complex (S. Uthamasamy);

Plant chemicals and the location of herbivorous arthropods by their natural enemies (D. W. Whitman and D. A. Nordlund);

Carnivory in phytophagous insects (D. W. Witman, M. S. Blum, and F. Slansky, Jr.);

Plant bodyguards: mutualistic interactions between plants and the third trophic level (D. Whitman);

Adaptational integration between gall-inducing insects and their host plants (A. Raman);

Host specificity: metapopulations and conservation: *Drosophila magnaquinaria* as a model (S. P. Courtney, M. Holbert, T. A. Singleton, T. T. Kibota, and D. M. Brosnan).

If there is a subtheme in these studies and others, it is that research is still driven by economics: Emphasis is usually on insects of economic concern (e.g., lepidopterans) or pretty ones (e.g., lepidopterans), with but rarely a statement that this insect is the best subject for the study undertaken.

And if there is a major theme in this book (and generally in the study of plant-insect interactions), it is the pre-eminence of chemical cues in regulating the interactions among (not between) plants, herbivores, and the latter's predators and parasites. These chemicals, not all volatile, may mediate the great majority of the short-range, and perhaps even more of the long-range, interactions. It follows then that the arthropods involved must be highly sensitive not just to the chemicals, but to nuanced differences—quantitative and qualitative—among them. (These arthropods would be splendid wine tasters.)

As the papers in this book show, we now know many of the chemicals themselves, and interest for some time has been moving from the organic chemistry of the system to its biology. This shift in interest emphasizes what the insects *do* (the verbs in my opening sentence), and how the plant controls, or attempts to control, that doing. The interaction often goes back and forth, each player responding to the other, both within the evolutionary script and with a certain improvisatory freedom. (I lack the courage to extend the metaphor by suggesting these authors are the drama critics, interpreting and commenting upon the action.) Study now is of the complex and subtle changes in chemistry and (especially) in consequent behavior. . . . Other cues are important too: visual, tactile, even perhaps auditory; and indeed one may be concerned that their significance is played down in contemporary research.

This book is a fine introduction to the study of these interactions, presenting summaries of earlier work and details of current work in good balance. Its emphasis on *effects* justifies "functional." Finally, I recommend not only this book to entomologists, but also the July/94 (v.6, no. 2) issue of *Phytophaga* which, like this book, is a gathering of fine papers on insect-plant ecology.

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Book Review

The Biology of Millipedes. Stephen P. Hopkin and Helen J. Read. Oxford University Press. 1992. xii + 233 pp. ISBN 0-19-857699-4. $70.00 (hardback).

This book complements *The Biology of Centipedes* (J. G. E. Lewis, 1981, Cambridge University Press) in providing basic biological information in English on the two major classes of myriapodous arthropods. The British authors perform a valuable service in assembling substantial information about this diverse class in relatively few pages, thereby expanding our knowledge of diplopods. As the first general text on millipedes in English, the work targets both specialists and beginning students, and is attractively bound with a cover illustration of a species of Siphonophorida, the order containing the millipedes with the most segments and legs.

Drs. Hopkin and Read surveyed about half of the estimated 1200–1500 non-taxonomic diplopod references and append a valuable bibliography of around 600 entries, but because the focus is general biology, they excluded most taxonomic works from their review. Consequently the book omits the considerable "biological" information in these studies, for example that on the development and life history of *Narceus americanus* (Beauvois), the common east-Nearctic spirobolid, reported in the family revision (Keeton, 1960, Mem. Am. Entomol. Soc. No. 17). A second consequence of the authors' decision to exclude taxonomic papers is the inadvertent use of archaic and ambiguous names. Prepublication review, particularly by specialists knowledgeable with distant faunas, is always advisable to ensure accurate nomenclature, but unfortunately this precaution was not sought regarding the Nearctic fauna. Furthermore, there is a tendency to overgeneralize about millipedes based on the Palearctic fauna, which is not completely representative of other zoogeographic regions, and inconsistent nomenclature detracts from its usefulness. I address major concerns here, focusing primarily on the Nearctic fauna.

The book is logically organized into 10 chapters—general introduction; taxonomy, evolution, and zoogeography; basic anatomy, locomotion, and ecomorphology; feeding and digestion; metabolism, excretion, and water balance; nervous, sensory, and neurosecretory systems; gametogenesis and fertilization; development, moulting, and life histories; predators, parasites, and defence; and ecology—that are informative and copiously illustrated using sources from the literature. With few exceptions, the illustrations are reproduced clearly, and scanning and transmission electron micrographs are often stunning. Each chapter is divided into sections and subsections designated by decimals (1.1, 1.2, etc.), and is comprised of short paragraphs that produce a readable text. The authors characterize the text as "introductory," and individuals seeking information about diplopodan ecology, behavior, and physiology will receive the basic essentials by reading the appropriate chapters. Treatment levels vary from moderate discussions and evaluations, to listings of results from key references, to statements that lack explanations. For example in Chapter 2, section 3, part 4 (hereafter cited as 2.3.4) on phylogeny, the authors mention, seemingly as an afterthought, that the *Nomenclator Generum et Familiarum Diplopodorum* (Jeekel, 1970, Monog. Nederl. Entom. Vereng., 5: 1–412) is "an extremely important work for diplopod taxonomists," without providing an expository syllable. Minimally, they should have referenced the preface in the *Classification of the Diplo-*

poda (R. L. Hoffman, 1980 ("1979"), Museum d'Histoire Naturelle, Geneva, Switzerland), where the *Nomenclator's* significance as "the most important single work ever published on the Diplopoda" is explained.

Most discussions are carried to reasonable conclusions, but several intriguing ones end abruptly, with literature citations that readers must research themselves. Thus, the section on respiration (5.2) concludes by listing references that contain "more details"; section 8.5.3.1 contains a list of eleven julid life history papers without commentary; section 6.3.1 concludes with a list of reviews on neurosecretion that "remove some of the confusion"; and the introductions to osmoregulation (5.6.1) and defensive secretions (9.3.1) contain listings of summary references that "provide more detail than is possible to include here." My reaction to such incomplete presentations was frustration, after having my interest "hooked."

For some published binomials that have undergone nomenclatural changes, the authors attempt to record both the old and new names, but they do so inconsistently. Some of the confusion is abated by thorough cross-referencing in the systematic index, but numerous problems still prevail. For example, *Oxidus gracilis* (C. L. Koch), the common household paradoxosomatid that has been introduced throughout North America, is reported as *Oxidus gracilis, Oxidus* (*Orthomorpha*) *gracilis, Orthomorpha* (*Oxidus*) *gracilis, Orthomorpha* (= *Oxidus*) *gracilis,* and *Paradesmus* (*Oxidus*) *gracilis.* Additionally, the authors cite *Aragosoma* (= *Pyreneosoma*) *barbieri* Mauries, *Jonespeltis splendidus* Verhoeff (= *Anoplodesmus saussurei* (Humbert)), *Metiche* (= *Epibolus*) *tanganyicense* Kraus, *Motyxia* Chamberlin (= *Luminodesmus* Loomis and Davenport), *Microchordeuma* (= *Melogona*) *gallicum* (Latzel), *Cylindroiulus frisius* (Verhoeff) (= *latestriatus* (Curtis)), etc. *Motyxia,* a California xystodesmid genus, is the senior synonym of *Luminodesmus,* the name in parentheses that was reported in the cited reference, but conversely *Epibolus,* the genus in parentheses for the preceding species, is senior to *Metiche.* Other names perplexed me, and beginning students and nontaxonomists will be bewildered by the inconsistent interchange of modern names and older published synonyms. Consequently with names like *Allajulus* (*Cylindroiulus*) *nitidus* (Verhoeff), one cannot determine whether *Cylindroiulus* is a subgenus, a synonym of *Allajulus,* or whether the reference used *Cylindroiulus* but the modern combination is *A. nitidus* or vice versa. The situation is further tangled by the usages of names like *Cylindroiulus punctatus* (Leach) and *A.* (*C.*) *nitidus* in the same sentence and paragraph (10.8.2). Does this mean that *punctatus* and *nitidus* are in different genera, or did the references cite them incorrectly, or did the authors forget to add *Allajulus* to the former, or what? In short, the nomenclatural presentation constitutes a formidable obstacle to comprehending the text.

While the authors try to indicate past and present binomials for some species, they use archaic names for four Nearctic species, thereby generating the false impression that this nomenclature is current. Many early names for Nearctic millipedes were used indiscriminately for several species, and many polyspecific genera were originally considered to be monotypic. Consequently, names like *Euryurus erythropygus* (Brandt) and *Fontaria virginiensis* (Drury) refer to several diplopods. Both of these species are now in other genera, *erythropygos,* correctly spelled with the "*os*" suffix, being in *Auturus* (Hoffman, 1978, Trans. Am. Entomol. Soc., 104: 37–68; Shelley, 1982, Can. J. Zool., 60: 3249–3267), and *virginiensis* being in *Apheloria* (Shelley, 1988, Can. J. Zool., 66: 1638–1663). Moreover, the status of the generic name *Fontaria* must be settled by a petition to the International Commission, and Hoffman (1980, op. cit., p. 144) recommends that it be rejected. *Fontaria* should not be used again

except to record an original combination, as in the caption of figure 7.7 (p. 112) for the holotype of *F. rubromarginata* Bollman, now in *Sigmoria* (*Sigiria*) (Shelley and Whitehead, 1986, Mem. Am. Entomol. Soc. No. 35). Below, I indicate the text and modern names for the incorrectly cited North American species.

Text Name	Page(s)	Modern Name	Reference
Chicobolus sp.	70	*C. spinigerus* (Wood)	Keeton, 1960, Mem. Am. Entomol. Soc., No. 17
Euryurus erythropygus	124	*Euryurus l. leachii* (Gray)	Hoffman, 1978, Trans. Am. Entomol. Soc., 104: 37–68
Apheloria corrugata	154	*A. virginiensis* (Drury)	Shelley, 1988, Can. J. Zool., 66:1638–1663
Fontaria virginiensis	167, 169	*Pleuroloma flavipes* Rafinesque	Shelley, 1980, Can. J. Zool., 58:129–168

The ordinal synopses in Chapter 2—taxonomy, evolution, and zoogeography—do not clearly indicate the distinguishing features, and readers should refer to the detailed accounts by Hoffman (1982, *in* S. P. Parker, ed., Synopsis and Classification of Living Organisms, 2: 689–724). Embellishments that would have been useful include indicating the approximate number of families, as a measure of internal diversity; more specific distribution statements, including biogeographic regions and/or continents; and an ordinal key. Recording the occupied continents or biogeographic regions would have informed readers that groups like the tropical order Glomeridesmida are absent from some areas, in this case tropical Africa. This chapter also contains errors and misleading statements concerning anatomical traits. In callipodids, the gonopods develop from the anterior pair of legs on segment 7 (8th legs) not the posterior pair, as is also erroneously reported in Hoffman (1982, op. cit.), but correctly stated in the ordinal synopsis of Hoffman and Lohmander (1964, Mitt. Hamburg Zool. Mus. Inst., 62: 101–151). It should also be emphasized that all polydesmids are blind, as stated in 8.5.2.3, and that the absence of ocelli is an autapomorphy of the order. Additionally in section 2.5, the cited paper on "mosaic complexes" (Shelley, 1976, Proc. Biol. Soc. Wash., 89: 17–38) addresses only one species, *Sigmoria* (*Sigmoria*) *latior* (Brolemann), even though the word "complex" is in the title. Better references on mosaics are the monographs on *Sigmoria* (Shelley and Whitehead, 1986, Mem. Am. Entomol. Soc. No. 35) and the family Eurymerodesmidae (Shelley, 1989, Mem. Am. Entomol. Soc. No. 37).

Because most diplopodologists, past and present, have resided in Europe, the Palearctic species are the best known millipedes and necessarily the focus of much of the book. However, that fauna is not completely representative of those of other continents, and some inaccurate generalizations are presented. For example, the family Paeromopodidae in the western United States counters the contention in 2.1.3.11 that the order Julida contains "rather small cylindrical millipedes," as occur in Europe. These North American diplopods attain a length of up to 165 mm (6½ in.) and dwarf all other julidans and most representatives of other orders (Hoffman, 1982, op. cit.; Shelley, 1994, Ent. Scand., 25: 169–214). Likewise, in the section on cuticular structure and coloration (3.2), the authors claim that "most millipedes are fairly dull in appearance or show cryptic coloration," although they previously acknowledge that some representatives of the order Spirobolida are brightly colored (2.1.3.9). This generalization accurately reflects the European fauna, but it does not hold for the faunas of

continents that are dominated by the polydesmid suborder Chelodesmidea, which is absent from Europe except for scattered sites along the Mediterranean. Most chelodesmoids are brightly colored, and many display bold aposematic markings in a wide range of patterns. The vivid pigmentations of many Xystodesmidae, which occur in east Asia and North and Central America, have been addressed in numerous publications, and Whitehead and Shelley (1992, Proc. Entomol. Soc. Wash., 94: 177–188) describe Müllerian mimicry among Appalachian species. Thus the statement that most millipedes are dull or cryptically colored misrepresents the Nearctic and tropical faunas that are dominated by the large, colorful representatives of the chelodesmoid families Xystodesmidae, Chelodesmidae, Platyrhacidae, Oxydesmidae, Gomphodesmidae, Eurymerodesmidae, and Rhacodesmidae. Colorful species also exist in other orders, for example certain African Odontopygidae and African and Neotropical Spirostreptidae (Spirostreptida), and the checkered and striped species of the Central American genus *Platydesmus* (Platydesmida: Platydesmidae).

In summary, it is abundantly evident that the authors devoted much time and energy to preparing this work, reviewing hundreds of references and spending several years developing a readable text. Drs. Hopkin and Read should be commended for accepting this task and covering so many aspects of milliped biology; I learned a lot from reviewing it, even correcting some personal misconceptions. *The Biology of Millipedes* marshals information on many topics from disparate sources, but in my view there are too many flaws, particularly regarding non-European forms. Unfortunately, the $70 cost is out of line with recent texts of greater depth of coverage on other invertebrates, and will dissuade many individuals from purchasing a copy.

I thank D. S. Lee, C. S. Crawford, R. L. Hoffman, C. L. Whitney, G. L. Miller, and T. J. Henry for constructive critiques of this review; Cathy Wood graciously performed repeated word processing chores.

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NEOTROPICAL TINEIDAE, VI: *PROSETOMORPHA FALCATA*, A NEW GENUS AND SPECIES OF SETOMORPHINAE (LEPIDOPTERA: TINEOIDEA) FROM COLOMBIA ASSOCIATED WITH CURCULIONID GALLERIES IN STEMS OF *SOLANUM*

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Abstract.—Adult and immature stages of ***Prosetomorpha falcata,*** a new genus and species of tineid moth from Colombia, are described and illustrated. *Prosetomorpha* is remarkable in being the most plesiomorphic setomorphine tineid discovered, as evidenced by the five-segmented maxillary palpi, moderately well developed haustellum, mandibles vestigial but distinct, female with signum present, and larva with six pairs of stemmata. Synapomorphies shared with other Setomorphinae include similar semi-appressed head vestiture, annulate but completely fused, eighth abdominal tergosternum in the male, membranous eighth abdominal segment without rami in the female, and larvae with unidentate mandibles. The larva is believed to be primarily a scavenger within the burrows of a curculionid weevil, *Faustinus apicalis* (Faust), that bores in the stems of *Solanum quitoensis* var. *quitoensis* Lamarck and *S. quitoensis* var. *septentrionale* R. E. Schultes. A braconid parasitoid, *Promicrogaster* sp., has been reared from burrows occupied by *Prosetomorpha.*

Key Words: Tineidae, Setomorphinae, *Prosetomorpha,* immatures, scavenger, host record, *Solanum,* Curculionidae, *Faustinus,* Neotropical

In the course of their investigations on the insect pests of *Solanum quitoensis* Lamarck, known locally as "lulo" or "naranjillo," entomologists at the Instituto Colombiano Agropecuario (ICA) of Bogotá, Colombia, have reared a previously unknown, stem-boring setomorphine moth, *Prosetomorpha falcata.* The larva was found frequently in association with larvae of the stem-boring weevil, *Faustinus apicalis* (Faust). Considering what is known of the larval biology of other Setomorphinae (Hinton 1956, Gozmány and Vari 1973, Zimmerman 1978, Robinson and Nielsen 1993), the new species probably feeds primarily as a scavenger within the tunnels of the weevil. Observations indicate, however, that living plant tissue is also consumed.

Morphological comparisons of the larva, pupa, and adult reveal that *Prosetomorpha* is a member of the Setomorphinae, a small, mostly neotropical subfamily, previously represented by two genera (*Setomorpha, Lindera*) and approximately eight species (Robinson and Nielsen 1993). *Prosetomorpha* is of phylogenetic interest in being the most plesiomorphic member of the subfamily, as evidenced by the five-segmented maxillary palpi (Figs. 13, 14), relatively well developed haustellum, mandibular vestiges distinct, female with signum present (Figs. 24, 25), and larva with six pairs of stemmata (Figs. 35, 55). The discovery of *Prosetomorpha* consequently broadens our definition of the subfamily, which previ-

ously had been characterized in part by moths with more reduced mouthparts and by larvae lacking stemmata (Hinton 1956, Zimmerman 1978, Robinson and Nielsen 1993). Synapomorphies shared with other Setomorphinae include similar semi-appressed head vestiture (Figs. 3, 4), slender annulate eighth abdominal sclerite with stout projections directed anteriorly in the male (Fig. 19), membranous eighth abdominal segment without rami in the female (Fig. 24), and larva with unidentate mandibles (Fig. 56). In addition to retaining the plesiomorphies listed above, *Prosetomorpha* differs most notably from *Lindera* and *Setomorpha* by the presence of 1 and ½ annuli of flagellar scales (a basal, dorsally abbreviated row and an entire distal annulus (Figs. 5, 6), falcate forewings, and a completely fused, eighth abdominal tergosternal ring in the male. In other Setomorphinae the adults possess a single annulus of flagellar scales, the forewings terminate in a simple rounded apex, and the eighth abdominal sclerite of the male is interrupted dorsally.

Prosetomorpha Davis, New Genus

Type species.—*Prosetomorpha falcata,* new species.

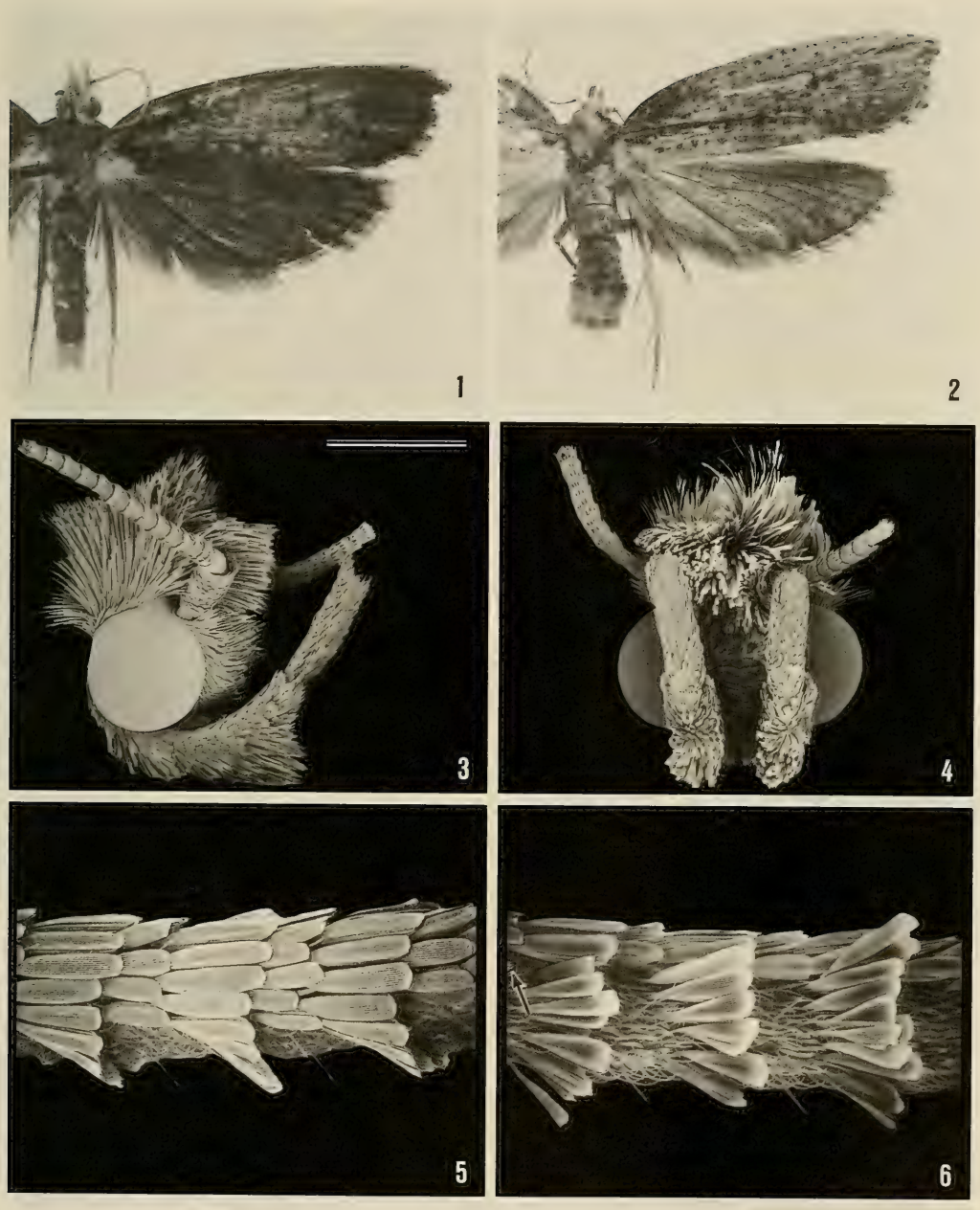
Adult.—Moderately large moths with falcate forewings; length of forewing = 8.5–13 mm.

Head (Figs. 3, 4, 13, 14): Vertex moderately rough with lateral tufts converging mesally over occiput and projecting anteriorly between antennae over frons; scales slender with bidentate apices. Frons relatively smooth, scales directed mesally. Antenna simple in both sexes; length ca. ⅓ of forewing; scape cylinrical, without pecten; flagellum (Figs. 5, 6) with two rows of slender scales per segment dorsally, with only the distal row forming a complete ring. Pilifers well developed, densely setose. Mandibles (Fig. 13) present but vestigial, equalling apical segment of maxillary palpus in length. Haustellum moderately developed (Fig. 14), slightly exceeding length of maxillary palpus. Maxillary palpus 5-segmented, with ratios from base = 0.2: 0.18: 0.18: 1: 0.33. Labial palpus 3-segmented; ratios from base = 0.43: 1: 0.88; segment II smooth dorsally and laterally, with rough, triangular tuft ventrally; bristles absent; segment III entirely smooth, depressed.

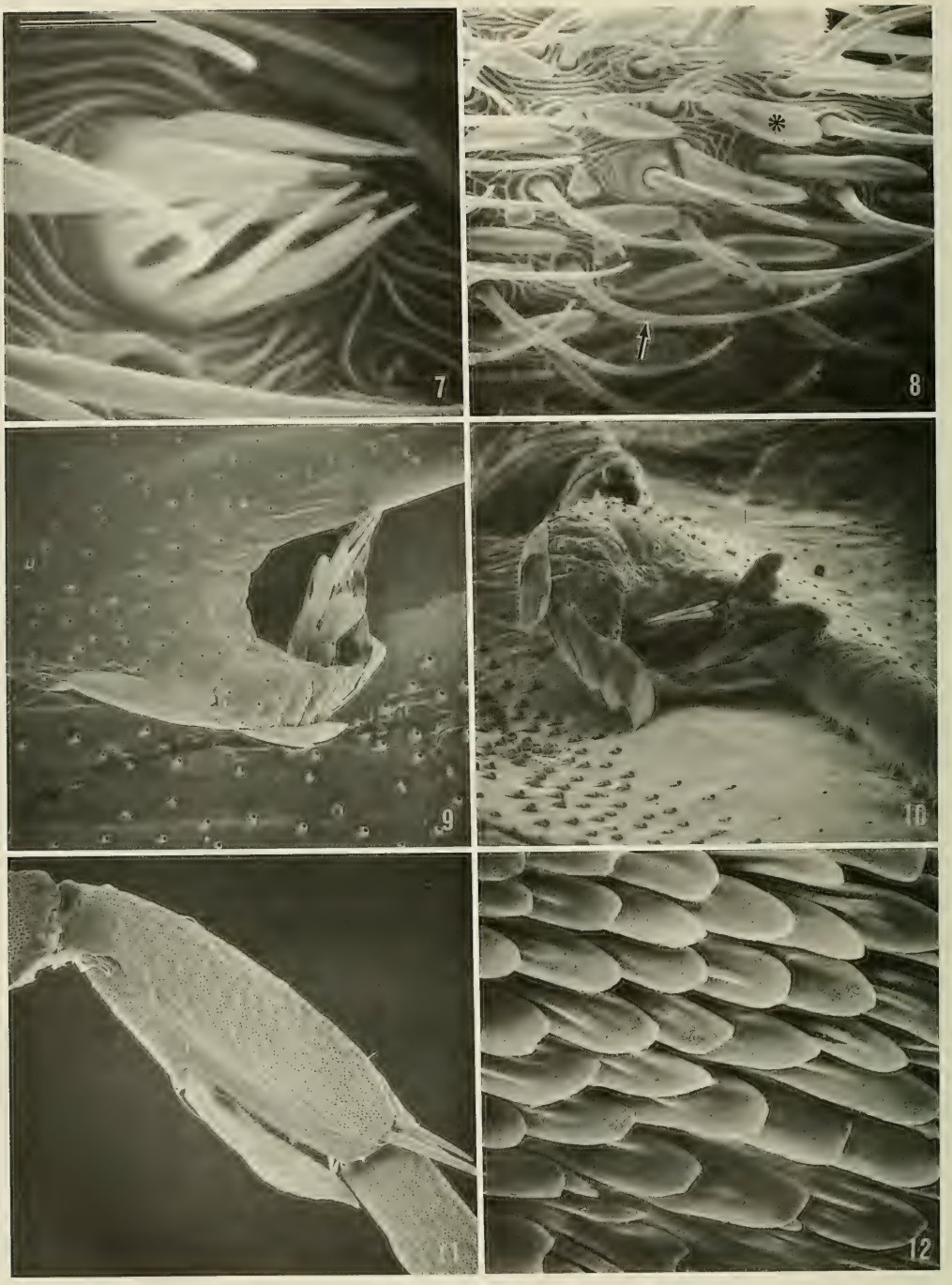
Thorax: Metafurcasternum (Figs. 16, 17) with anteromedial process (APM) elongate, slender, with a pair of furcal apophyses (FA) directed sharply anteriorly; furcal ridge continues caudally and terminates as a pair of rounded lobes arising inside lamina of secondary furcal arms (LSF). Forewing (Fig. 15) falcate, abruptly indented between apex and M1; R 5-branched; R4 and 5 stalked half their length; R5 terminating before apex; all 3 branches of M separate; CuA1 and 2 arising approximate; A1 and 2 fused except for fork at basal third; accessory cell present; base of media usually not evident within discal cell; retinaculum of male a tightly curled flap (Figs. 9, 10). Hindwing with all veins arising separate; M 3-branched; base of media divided within cell; male with a single stout frenulum; female with 2 smaller frenular bristles. Foreleg (Fig. 11, 12, 18) with epiphysis ca. 0.5 the length of shortened tibia, the latter equal in length to tarsomere I. Tibial spurs = 0–2–4. Apices of all tibiae and tarsomeres with 3 stout, spiniform setae (Fig. 11).

Abdomen (Fig. 19): Sternal apophyses slender, ca. half the length of S2. Eighth segment of male with a slender, sclerotized ring completely encircling segment; a pair of slender projections arising laterally from ring; T7 reduced, triangular. A pair of nonretractible coremata arising ventrally from S8 of male. Corethrogyne of female consisting of a dense ring of elongate, straight setae.

Male genitalia: Tegumen reduced to a narrow dorsal ring. Vinculum similar to and contiuous with tegumen as a narrow ventral ring; saccus short, ca. 0.14 the length of valva, compressed. Valva long, ca. 1.3× the



Figs. 1–6. *Prosetomorpha falcata.* 1, Adult male, forewing length 10.6 mm. 2, Female, forewing length 14 mm. 3, Head, lateral view (0.75 mm). 4, Anterior view of Fig. 3. 5, Lateral view of antenna at distal third showing two dorsal rows of scales (annuli; 100 μm). 6, Ventral view of Fig. 5 showing continuation of distal row of scales and position of sensilla coeloconicum (see arrow; 100 μm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 3.)



Figs. 7–12. *Prosetomorpha falcata,* adult. 7, Sensilla coeloconicum shown in Fig. 6 (5 μm). 8, Ventral sensilla of antenna showing details of sensilla chaetica (arrow) and sensilla auricillica (asterisk) (15 μm). 9, Male retinaculum, ventral view, (120 μm). 10, Distal view of Fig. 9 (100 μm). 11, Foretibia with epiphysis and apical spines (176 μm). 12, Detail of epiphysis showing flat spines (comb; 6 μm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 7.)

length of genital capsule; sacculus moderately broad, gradually narrowing to extremely slender cucullus (Fig. 22), bearing a small recurved spine at apex. Juxta a flat, subrectangular, elongate plate, with length ca. 2× width. Aedoeagus a relatively simple, slightly depressed, elongate, and slightly curved (viewed laterally) tube; cornuti absent.

Female genitalia: Ovipositor elongate, telescoping. Posterior apophyses 1.7× the length of anterior pair. Ventral pseudapophyses absent. Ostium bursae indistinct, broad; a small, sclerotized, triangular sclerite (lamella postvaginalis; Fig. 24, LP) immediately caudad to ostium; lamella postvaginalis with a slender keel-like process extending anteriorly; ductus bursae mostly broad, membranous except for a dense, elongate patch of minute spinules from anterior end that extends to signum within corpus bursae; corpus bursae moderately enlarged (Fig. 24), with a single densely spinose signum (Fig. 25).

Etymology.—The generic name is derived from the Greek prefix *pro* (before) combined with the generic name *Setomorpha.* It is considered feminine in gender.

Prosetomorpha falcata Davis, New Species

Male (Fig. 1).—Length of forewing 8.5–10.1 mm. *Head* (Figs. 3, 4, 13, 14): Vertex buff to dark brown; frons paler, cream to buff. Antenna with scape mostly fuscous, paler ventrally; flagellum light brown, covered with narrow scales dorsally, mostly naked ventrally except for dense pubescence of short sensilla chaetica and dense, slender sensilla auricillica (Fig. 8). Maxillary palpus cream to white. Labial palpus mostly cream to white with external sides of I and II irrorated with fuscous. *Thorax:* Dorsum brown, irrorated with fuscous; tegulae mostly fuscous. Venter pale buff to cream. Forewing variably light to dark brown, finely spotted with small clusters of dark fuscous scales, fringe similarly mottled with light to dark brown scales with suffusion of cream around tornus. Hindwing uniformly fuscous except for streak of white along costa, broadest at wing base and narrowing toward apex; fringe generally lighter in color, gray along hind margin becoming more white toward apex with streaks of fuscous. Legs mostly dark fuscous dorsally, pale buff ventrally, with buff banding on tibia and more faint at apices of tibia and tarsomeres. Hindleg much paler, lighter brown. *Abdomen:* Dark fuscous dorsally and laterally, cream ventrally with long, cream, piliform scales over A8 largely covering genitalia.

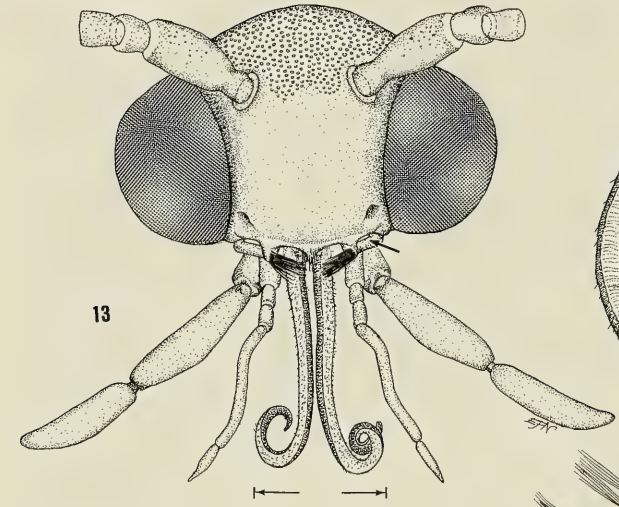
Female (Fig. 2).—Length of forewing 10.5–13.0 mm. Generally paler than male. *Head:* Light brown to white with light brown scaling laterally on labial palpus. Forewing light brown with fuscous spots more evident. Hindwing gray with whitish costal streak as in male. Legs with similar markings to male but generally lighter in color.

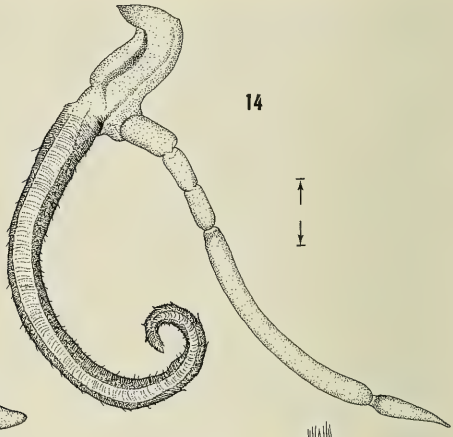
Male genitalia (Figs. 20–23).—As described for genus.

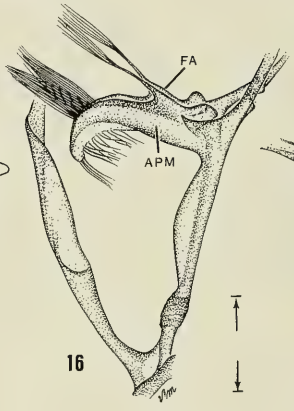
Female genitalia (Figs. 24, 25).—As described for genus.

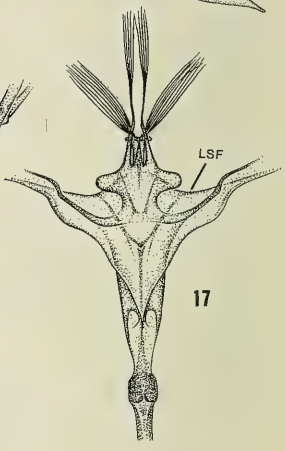
Larva (Figs. 30–42, 49–58).—Length of largest larva 20 mm, maximum diameter 2.9 mm. Body generally white with distinct dark brown plates and pinacula (Figs. 49, 50).

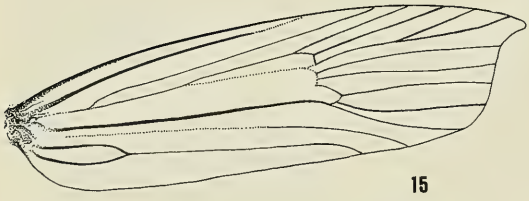
Head: Maximum width 2.7 mm. Color reddish brown, becoming darker over frons and along anterior margins. Chaetotaxy as illustrated (Figs. 30–32, 34, 52, 53, 55); AF 1 absent. Stemmata (Figs. 35, 55) consisting of 6 pairs, with 3–5 contiguous near lateral rim of antennal socket, and 6 more remote and ventral. Mandible unidentate (Fig. 56). Spinneret (Fig. 33) slender and elongate with a minute orifice. Labial palpus 2-segmented, slender and elongate, ca. 0.8 the length of spinneret; apical segment less than ⅓ the length of basal segment; apical seta 1.5× the length of second segment. Apex of mentum with a pair of minute secondary labial setae (Fig. 33).

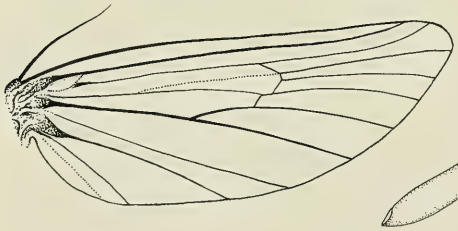


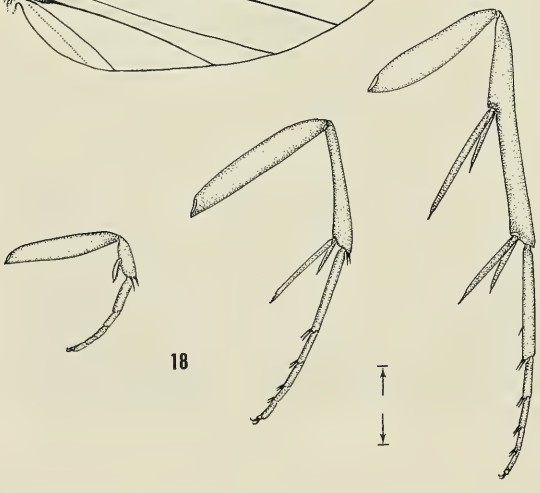


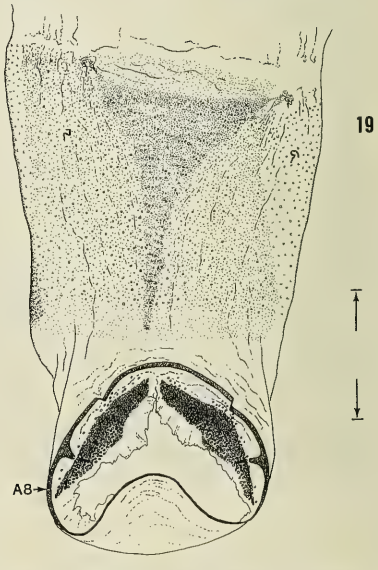




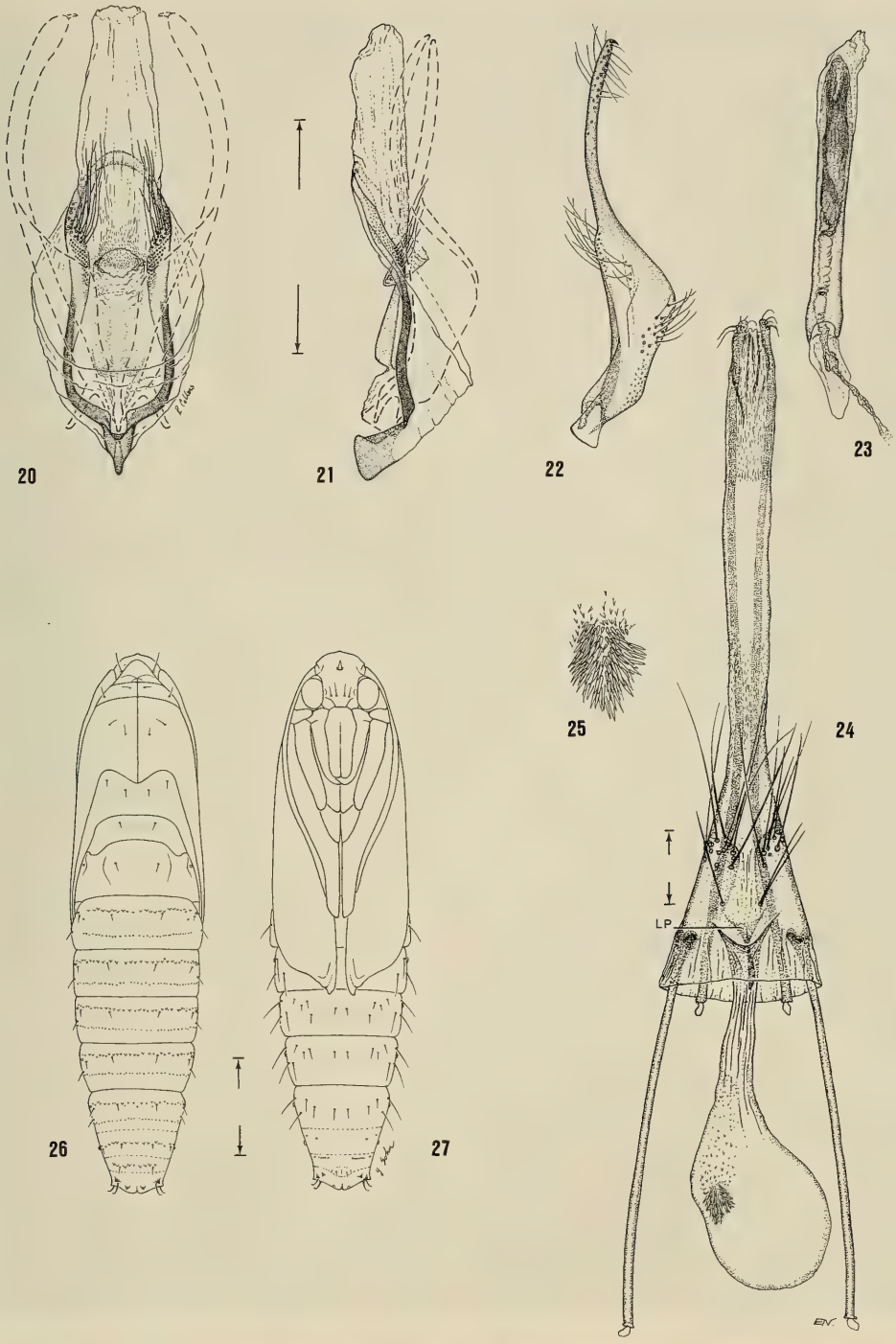




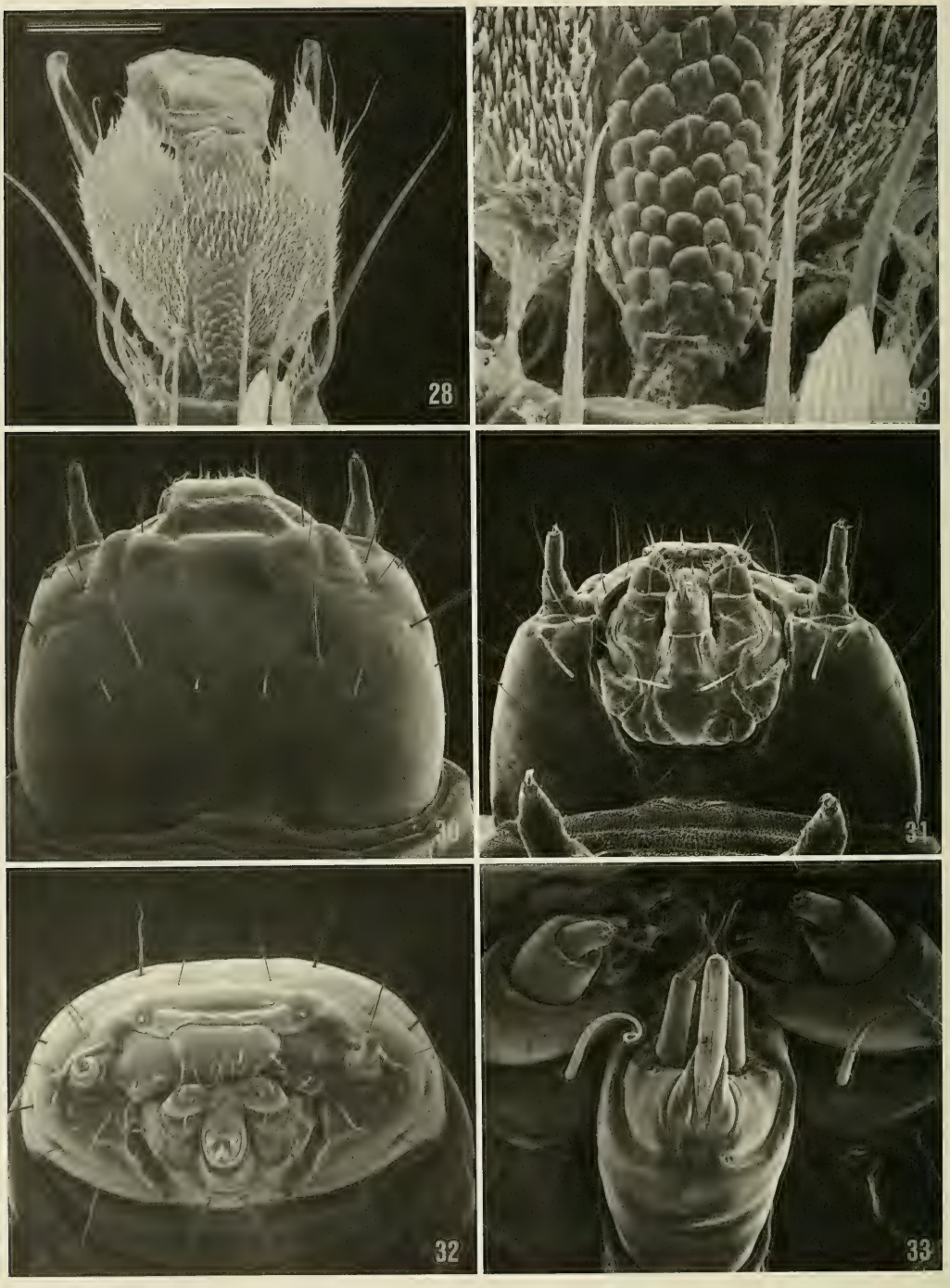




Figs. 13–19. *Prosetomorpha falcata,* adult. 13, Head, anterior view; mandible (see arrow; 0.5 mm). 14, Detail of maxilla (0.2 mm). 15, Wing venation. 16, Metafurcasternum, lateral view (0.5 mm). 17, Caudal view of Fig. 16. 18, Leg structure (1 mm). 19, Ventral view of male abdominal segments 7–8; note complete, sclerotized ring on A8 (0.5 mm). (Scale lengths in parentheses.)



Figs. 20–27. *Prosetomorpha falcata,* adult. 20. Male genitalia, ventral view (0.5 mm). 21, Lateral view. 22, Mesal view of valva. 23, Ventral view of aedoeagus. 24, Female genitalia, ventral view; LP = lamella postvaginalis (0.5 mm). 25, Enlarged detail of signum shown in Fig. 24. 26, Pupa, dorsal view (2 mm). 27, Ventral view. (Scale lengths in parentheses.)



Figs. 28–33. *Prosetomorpha falcata.* 28–29, Adult: 28, Pretarsus of hindleg, ventral view (38 μm). 29, Detail of unguitractor plate in Fig. 28 (12 μm). 30–33, Last instar larva: 30, Head, dorsal view (0.43 mm). 31, Head, ventral view (0.43 mm). 32, Head, anterior view (0.43 mm). 33, ventral view of maxilla and labium (100 μm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 28.)

Thorax: Pronotum and spiracular plates dark reddish brown. Lateral setae trisetose and together with spiracle on same plate; a crescent shaped, hyaline separation immediately anterior to spiracle (Fig. 51). Meso- and metathorax with L3 arising on separate pinacula from L1–2. MSD1 and 2 reduced, of similar lengths. Legs well developed; tarsal claw moderately stout, with an abruptly enlarged base (Fig. 38). Coxae widely separated, bearing 6 setae.

Abdomen: L1–3 on separate pinacula on segments A1–8; L2 and 3 together on A9. SV trisetose on A1–8, with SV1 and 3 together on same pinacula on A1–6. Anal plate with 5 pairs of setae, including extra seta XD1 (Fig. 51). Prolegs well developed on A3–6 and 10; crochets A3–6 uniordinal, uniserial, and arranged in a complete ellipse of approximately 45–47 hooks; a scattered band of smaller, numerous spines encircling apex of planta (Fig. 39); crochets on A10 consisting of a single row of approximately 20–22 hooks along anterior edge of planta (Fig. 42).

Pupa (Figs. 26, 27, 43–45, 59–64).—Length 9–11.3 mm; width 2.9–3.3 mm. Color usually light reddish brown, becoming darker anteriorly. Head smooth except for a minute, subapical, slightly curved spine projecting anteriorly and appressed to head (Fig. 45); length of spine ca. 90 μm long. Labrum with a pair of lateral setae (Fig. 59). Forewings extending beyond caudal margin of A4 (Fig. 27). Hindlegs only to middle of A3. A3–7 with a small anterior row of spines and a smaller, caudal row of spines; tabulation of spines as follow: A3, anterior = 26–29, posterior = 51–58; A4 (Fig. 60), anterior = 43–47, posterior = 67–75; A5, anterior = 50–60, posterior = 70–77; A6, anterior = 42–49, posterior = 63–71; A7, anterior = 34–38, posterior = 24–28; A8 = 17–19; A9 = 9–10. A10 encircled by 8 stout spines of equal size (Figs. 61–64) as follow: a dorsal pair, 2 lateral pairs bearing short setae, and a ventral pair separated further apart than dorsal pair.

Holotype.—♂; COLOMBIA: Anolaima, 1560 m, Cundinamarica Prov.; Oct 1988, I. Zenner, ex stem of *Solanum quitoensis* [var. *septentrionalis* R. E. Schultes], USNM.

Paratypes.—Same data as holotype: 6 ♂, 9 ♀, 11 cocoons, slides USNM 30429, 30430, 30597, 30598, 31566, 31573, (BMNH, ICAB, USNM); Same locality as holotype: 2 ♂, 2 ♀, May 1990, I. Zenner, ex stem of *Solanum quitoensis* [var. *quitoensis* Lamarck, (ICAB, USNM); 13 larvae, slides USNM 30599, 30600, 30677, 8 pupae, slides USNM 30602, 30603, 31605, May 1988, ex stems of *Solanum quitoensis* [var. *septentrionalis* R. E. Schultes, (USNM).

Hosts.—Solanaceae: *Solanum quitoensis*; Zenner-Polanía (in corres. 6 Jun 1990) reports both the spiny variety *septentrionalis* R. E. Schultes and the smooth variety *quitoensis* Lamarck as hosts.

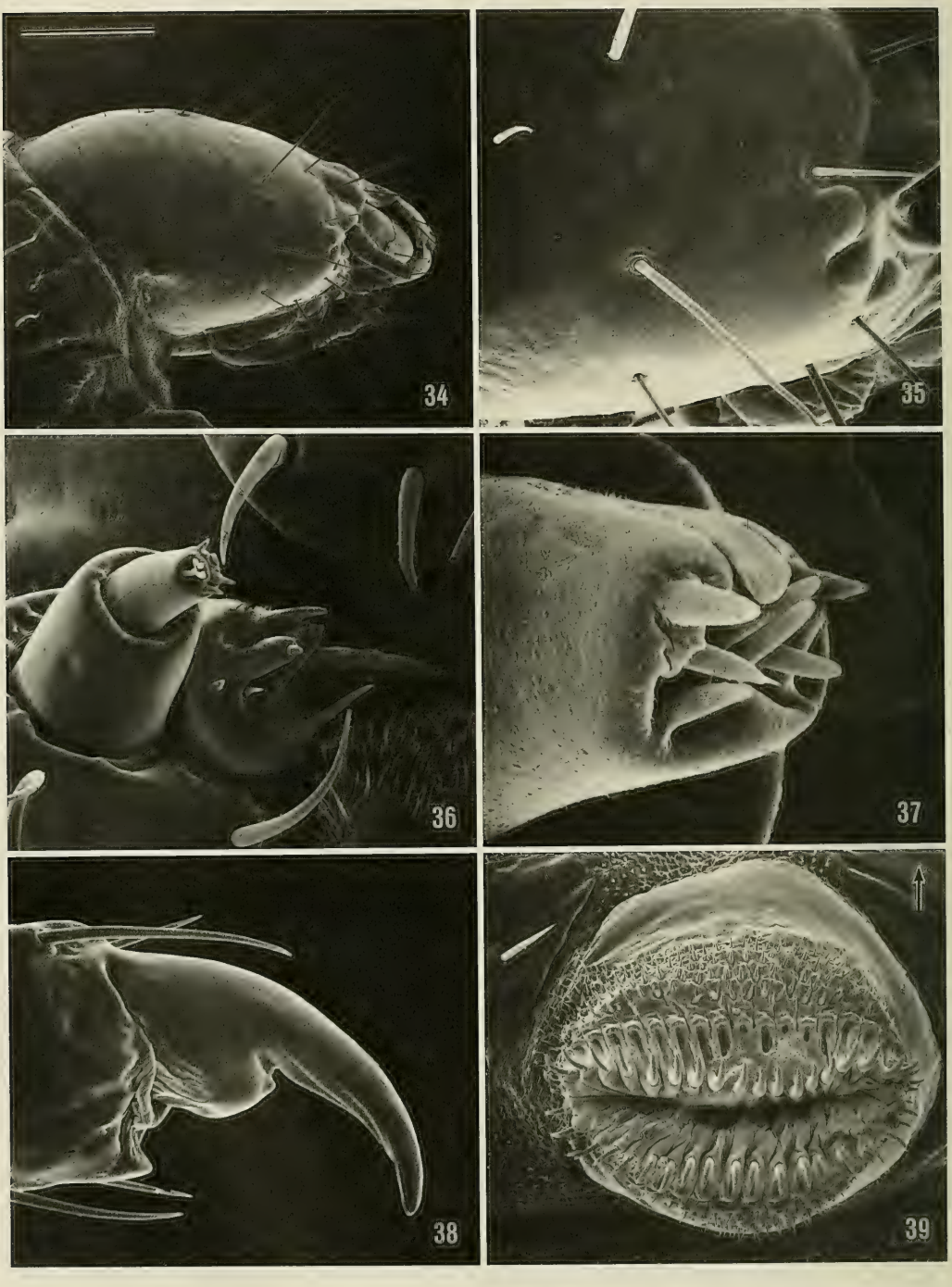
Parasitoid.—Braconidae: *Promicrogaster* sp. (det. P. M. Marsh).

Distribution.—Reported only from the type locality in central Colombia.

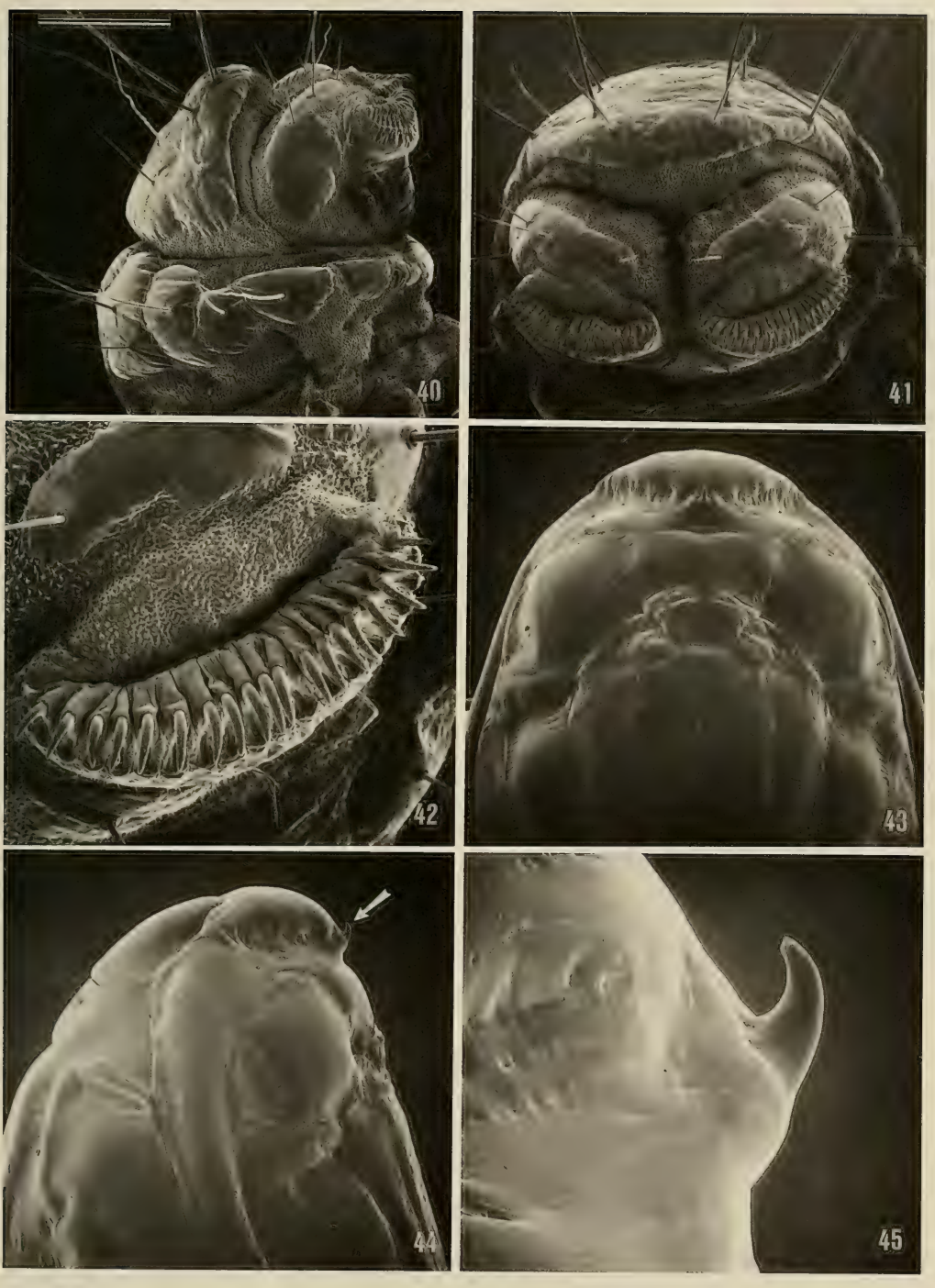
Etymology.—The specific epithet is derived from the Latin *falcatus* (sickled-shaped, hooked) in reference to the falcate-tipped forewings.

Discussion.—Zenner-Polanía (personal correspondence 19 June 1989) reports that larvae of *P. falcata* feed within the stems of *Solanum quitoensis,* generally in groups of 3 to 5. Sometimes they co-occur with larvae of the stem-boring weevil, *Faustinus apicalis,* apparently scavenging in the detritus left by the latter. In freshly damaged stems, however, *Prosetomorpha* larvae appear to consume living plant tissue, thus resembling the broader feeding habit of a few *Opogona* (Davis and Peña 1990). Infested stems are typically swollen (Figs. 46, 47). Damage has been observed only in plants 10 months or older. After that period, even mature plants with stem diameters up to 10 cm are tunneled.

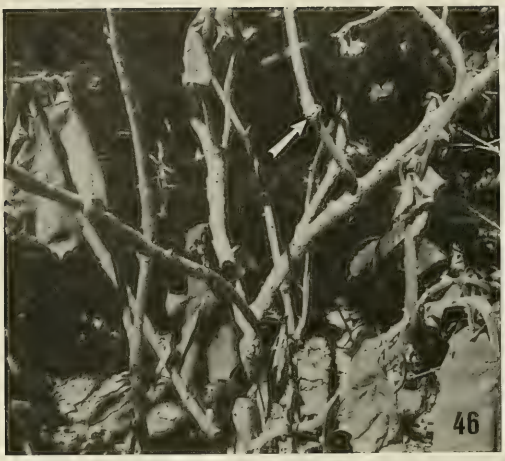
Older larvae are often found exposed within the galleries, with younger larvae most frequently occurring within flimsy, silken cases covered with frass. In the field,

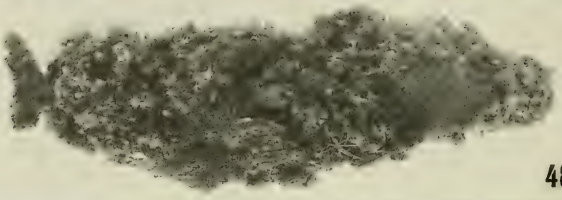


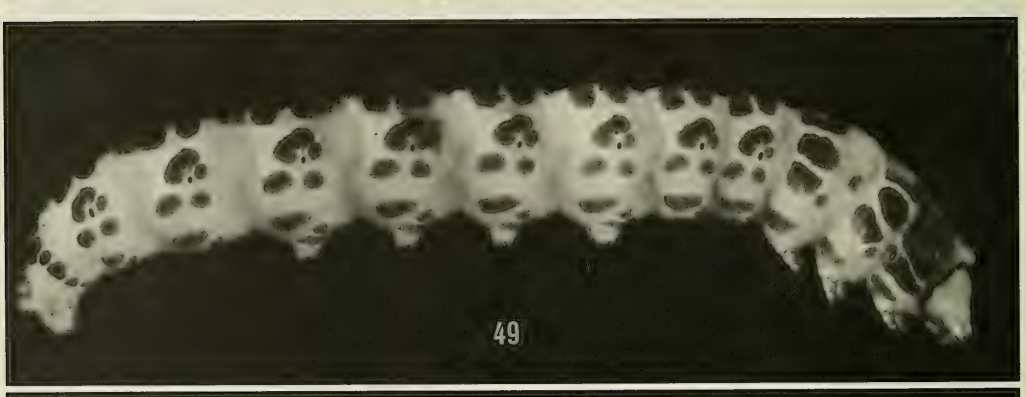
Figs. 34–39. *Prosetomorpha falcata,* last instar larva. 34, Head, lateral view (0.46 mm). 35, Detail of stemmatal area in Fig. 34 (150 μm). 36, Maxilla (43 μm). 37, Detail of sensilla at apex of maxillary palpus (8.6 μm). 38, Pretarsus of metathoracic leg (43 μm). 39, Right proleg, A4 (arrow = anterior; 158 μm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 34.)

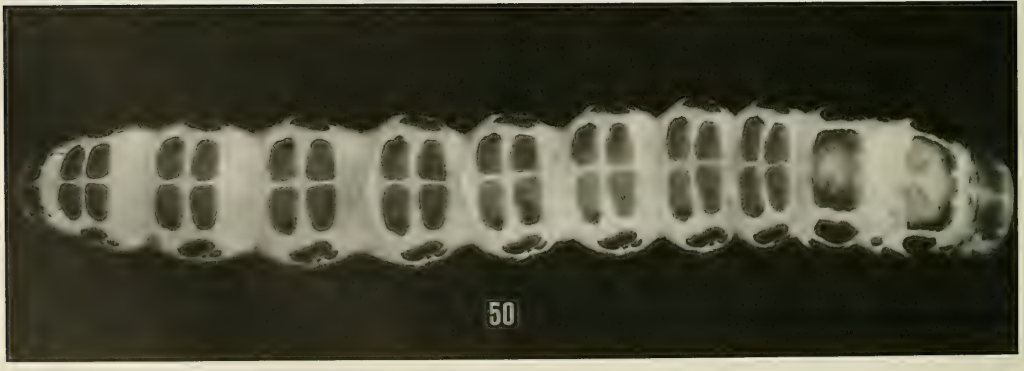


Figs. 40–45. *Prosetomorpha falcata.* 40–42, last instar larva: 40, Lateral view of A9–10 (0.5 mm). 41, Caudal view of A10 (0.43 mm). 42, Right proleg of A10 (150 μm). 43–45, Pupa: 43, Head, ventral view (0.6 mm). 44, Lateral view of Fig. 43 (0.6 mm). 45, Detail of frontal spine (with broken tip) in Fig. 44 (see arrow; 75 μm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 40.)

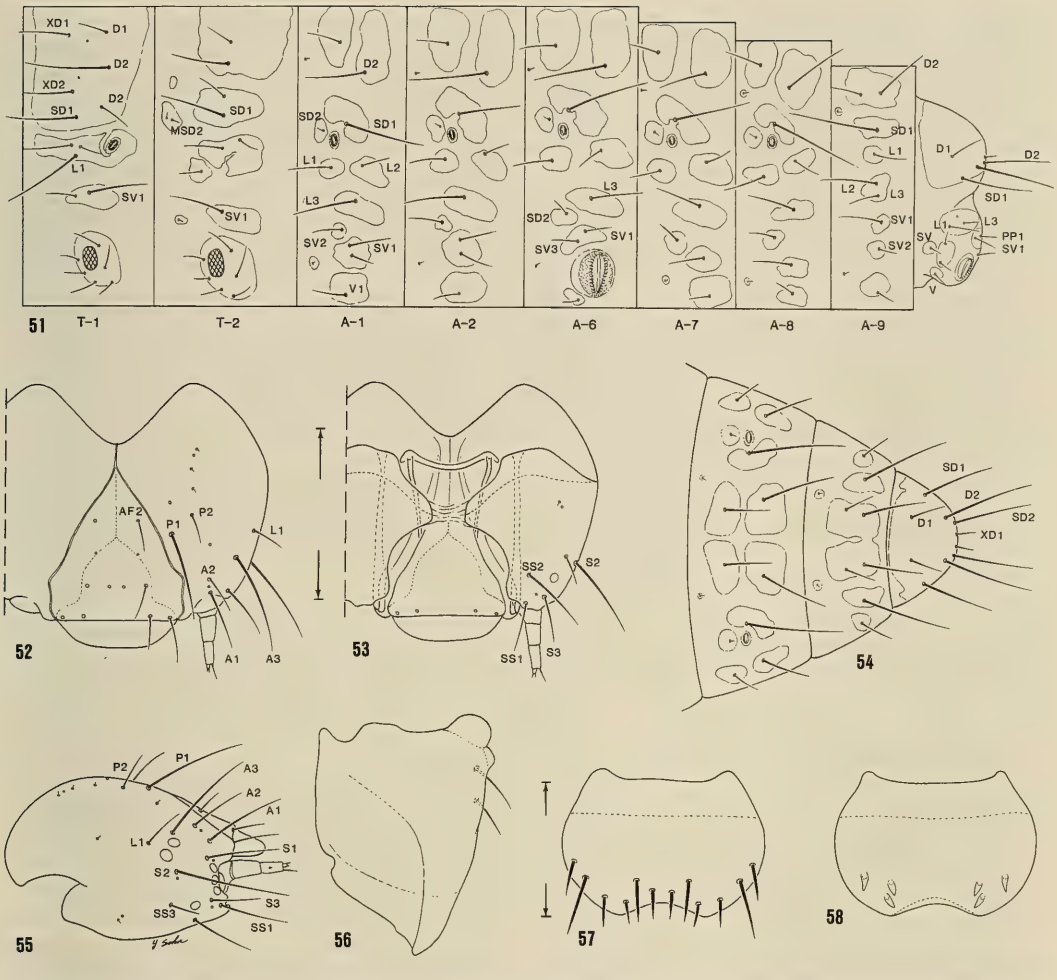








Figs. 46–50. *Prosetomorpha falcata.* 46, *Solanum quitoensis* damaged by stem-boring larvae of weevil, *Faustina apicalis,* and tineid, *Prosetomorpha falcata.* Arrow points to infested site indicated by swollen stem. 47, Closeup of swollen stem with protruding frass of *Prosetomorpha* (arrows). 48, Cocoon (23 mm). 49, Last instar larva, lateral view (20 mm). 50, Dorsal view. (Specimen lengths in parentheses.)

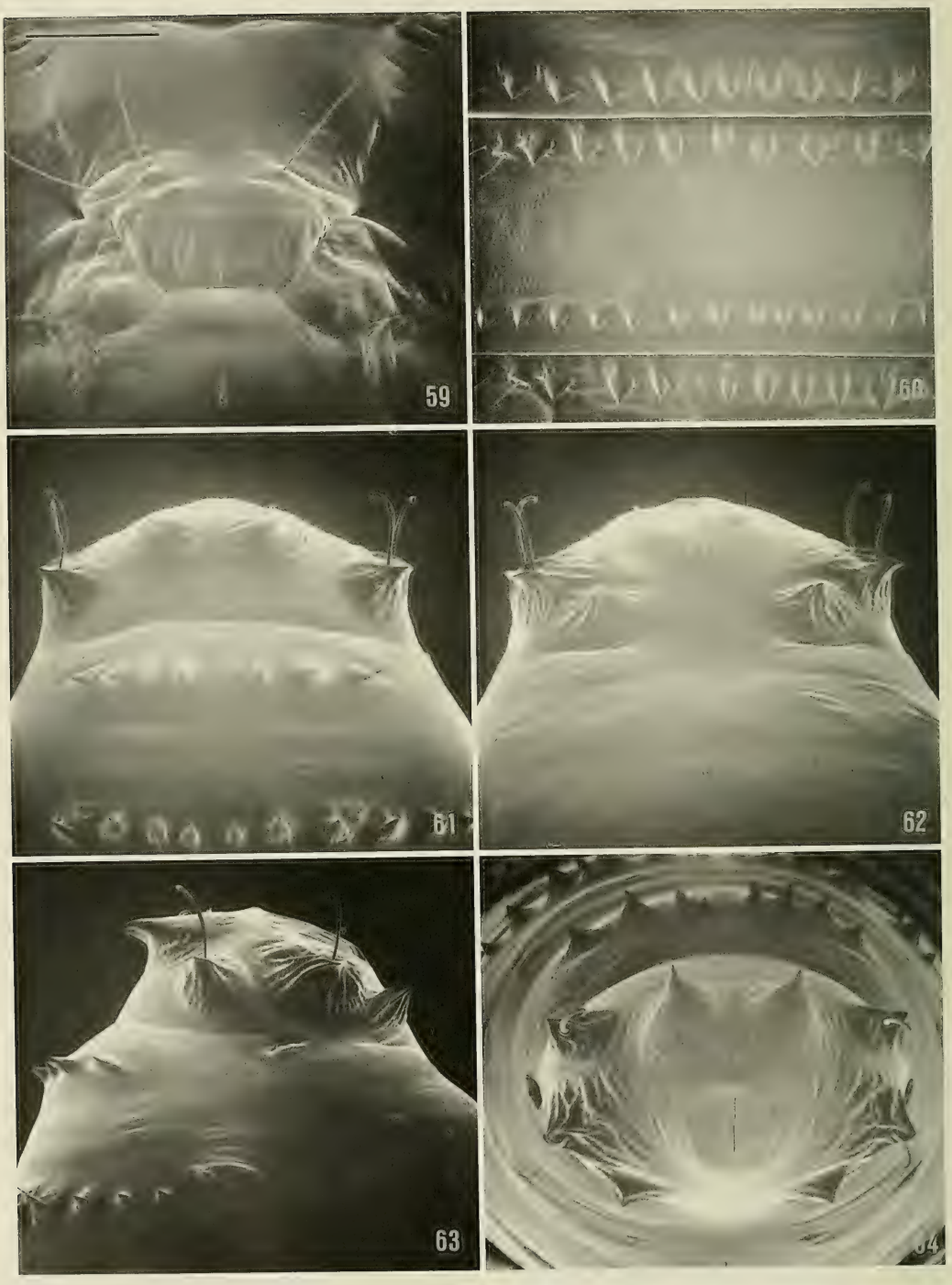


Figs. 51–58. *Prosetomorpha falcata,* morphology of last instar larva. 51, Chaetotaxy of pro- and mesothorax, abdominal segments 1, 2, 6–10. 52, Head, dorsal view (0.5 mm). 53, Ventral view. 54, Abdominal segments 8–10, dorsal view. 55, Head, lateral view. 56, Mandible (0.3 mm). 57, Labrum, dorsal view. 58, ventral view (0.3 mm). (Specimen lengths in parentheses.)

plant damage can be detected by the extrusion of silk-entwined frass from a "cleaning hole" in the stem (Fig. 47). This hole is never used as an exit by the moth; instead, the last instar larva chews another hole and pupates within a dark silken, frass covered cocoon, measuring up to 23 mm long and 6 mm in diameter (Fig. 48), that is formed inside the stem near the future exit hole. Following adult emergence, the pupal exuvium can be found protuding from this hole.

Because the larvae tend to be gregarious, their concentrated feeding often weakens the stems sufficiently to facilitate breakage on windy days. In this manner, the larval feeding of *P. falcata* can be instrumental in the death of damage stems and, at times, even the entire plant.

The full complement of six pairs of stemmata easily distinguishes larvae of *P. falcata* from that of *Setomorpha* and *Lindera* (both without stemmata). The chaetotaxy of all three genera is very similar, including the shared presence of five pairs of setae on the anal plate (Fig. 54). *Prosetomorpha* dif-



Figs. 59–64. *Prosetomorpha falcata,* pupa. 59, Frontal region of head, ventral view (250 μm). 60, Double rows of dorsal spines on abdominal segment 5 and portions of A4 and 6 (0.3 mm). 61, Dorsal view of A9–10 (0.38 mm). 62, Ventral view of A9–10 (0.38 mm). 63, Lateral view of A9–10 (0.38 mm). 64, Caudal view of A10. (Scale lengths in parentheses; bar scale for all photographs = Fig. 59.)

fers in having lost the first adfrontal seta and in possessing an additional seta (PP1) on A10 (Fig. 51).

Acknowledgments

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BEHAVIOR OF NESTING *EPISYRON CONTERMINUS POSTERUS* (FOX) AND ITS CLEPTOPARASITE *EPHUTA S. SLOSSONAE* (FOX) (HYMENOPTERA: POMPILIDAE, MUTILLIDAE)

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Abstract.—Behavior of the nesting spider wasp, *Episyron conterminus posterus* (Fox) and its cleptoparasite, *Ephuta s. slossonae* (Fox) were studied near Lake Annie in the sand pine scrub of Archbold Biological Station, Lake Placid, Florida. Nest burrows of *E. c. posterus,* 5.0–8.5 cm in length, were usually dug at a 45° angle into sandy, unvegetated soil. Excavation of several empty burrows prior to provisioning a nest was commonly observed. Each nest was provisioned with a single araneid spider, *Eustala anastera* (Walckenaer). Prey capture occurred prior to nest digging, and the paralyzed spider was cached on low vegetation near the nesting site. Spiders were dragged by their legs into the nest. Closure and concealment of the burrow quickly followed nest provisioning. Behavior of receptive female *Ephuta* and their attracted males is described. Details of female searching behavior, inspection of empty *Episyron* burrows, and entry into a closed, provisioned nest are provided. We report here for the first time, a mutillid probably feeding upon the host egg on the spider prey, and ovipositing within the body of its host's prey. A review of the known or suspected hosts of *Ephuta* suggests that the latter are obligate cleptoparasites of Pompilidae (spider wasps).

Key Words: *Episyron, Ephuta,* spider wasp, mutillid, cleptoparasite, empty burrows, Pompilidae, Mutillidae

Early in April, 1993 and 1995, we observed the behavior of *Episyron conterminus posterus* (Fox), and its cleptoparasite, *Ephuta s. slossonae* (Fox) at the Archbold Biological Station (ABS), Lake Placid, Florida. Observations of the wasps were made near Lake Annie along a narrow section ca 325 m long of a sand road paralleling Florida State Road 70 (Fig. 1).

Episyron conterminus posterus (Fox) (Fig. 2)

Nesting and prey records for *E. c. posterus* have been reported by a number of observers (Krombein, 1979; Kurczewski, 1981; Kurczewski and Spofford, 1986). It was the most abundant pompiline at ABS where it nested principally in unvegetated white sand. Mark Deyrup (personal communication) collected over 655 individuals in three Malaise traps during his 1986 ABS insect survey.

Prey hunting and transport.—The wasps hunted for prey in the sand pine scrub adjacent to the nesting sites. We did not witness prey capture, but three spiders taken from wasps or their nests were females of the araneid, *Eustala anastera* (Walckenaer), ca 7 mm long. Levi (1977) noted that at ABS this spider made its web each evening after dark, and that most webs had been removed by morning. The species makes no

Fig. 1. Excavation site for nest of *Episyron conterminus posterus* in the sand road adjacent to Lake Annie, Archbold Biological Station, Florida.

retreat, but rests on dead branches when not in the center of the web. Such habits make it vulnerable to predation by *Episyron*. Prey capture occurs prior to nest construction. The wasp transports the paralyzed spider to the nesting area by flying with it if the prey is small, or by carrying a larger prey up a low plant, and making a short flight, followed by one or more similar sequences. Near the site where nest digging will be initiated, the wasp drags the spider up a small plant and caches it in the angle between a leaf and the main stem. We watched one female try several times unsuccessfully to drag her spider up a grass blade and get it to stay near the tip.

Nest excavation.—Females ready to initiate nest digging walked rapidly over the sand quite erratically, and occasionally flew low over the ground. Digging of empty burrows was frequently observed prior to digging the burrow that would contain the spider prey. The empty burrows extended downward to the level of damp sand similar to nest burrows. One female was observed digging seven empty burrows before provisioning and closing one of them (Fig. 2). Occasionally, she revisited an empty burrow to remove some sand grains, and then returned to work on the true nest. Most burrows entered the ground at a 45° angle. The raised mounds of sand adjacent to tire ruts appeared to be more attractive nesting sites than the surrounding level ground. Burrows (n = 25) measured 5.0–8.5 cm in length. Burrow openings were circular and ranged from 0.8 to 1.0 cm in diameter. A spoil heap of sand excavated from the burrows fanned out in a triangular pattern on the downslope below the nest openings. The terminal cell was spheroidal, often slightly wider than the burrow diameter, and was always in damp sand.

Nest provisioning.—Once burrow excavation was completed, females brought their paralyzed prey to the nest. These spiders were dragged by the legs, and deposited in front of nest openings. One female was observed pulling and pushing her prey over the sand for a distance of more than 150 cm from where it had been placed. Females then entered their burrows once or twice more, each time bringing sand grains

Fig. 2. *Episyron conterminus posterus*. Diagram of nest entrance and position of empty burrows.

to the opening, and kicking them out. Presumably, a cell was being created of the proper dimensions to accomodate the prey. Females inspected their prey, entered their nests, then came to the opening head first, and pulled their spiders inside.

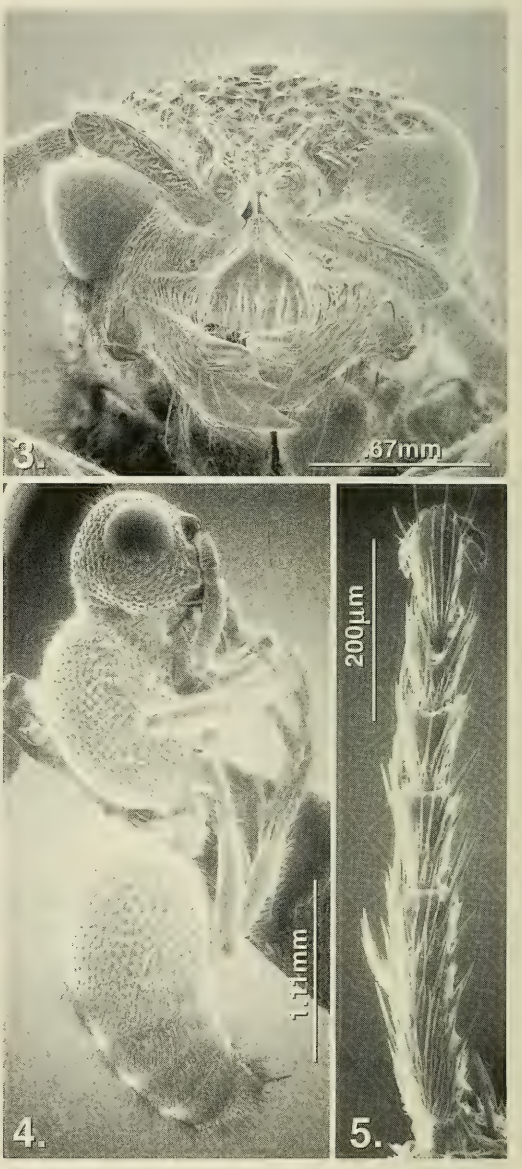
Nest closure.—Within several minutes of placing prey in their nests, females began nest closure and concealment. Appearing at the nest opening, females raked sand from the spoil heap into the burrow to fill it. *Episyron* raked sand down into their burrows and after plugging them nearly to the surface, most of the remaining spoil heap was raked away. Females then raked off the edges of the area where the opening had been, thus obliterating the remaining small depression. Finally, several minutes were spent scattering sand grains over the nesting area. One female, timed from initiation to completion of nest closure, spent 24 minutes plugging and concealing her nest.

Ephuta slossonae slossonae (Fox)
(Figs. 3–6)

This small species with females 3.2–4.8 mm long (Fig. 4), was the most common *Ephuta* in the study area. We saw only one female of the somewhat larger *E. puteola* (Blake) in this area.

Mating behavior.—Most of the female *E. s. slossonae* we observed walked over the sand with their abdomens held horizontally. These females appeared to be engaged in searching behaviors and were never observed to attract males.

However, one female observed during 1993 and two females in 1995, displayed what we interpreted as a mating posture, and all attracted males. These three pristine females walked more slowly than other female *Ephuta*. A bobbing up and down of the abdomen occurred as they walked, and when stopped, their abdomens were raised almost vertically. We presume that a sex pheromone was being dispersed during these movements. One pair was collected after the male flew over the female, rapidly pounced, apparently seizing her with his large mandibles (Fig. 3), then lifted her from the substrate. The other two pairs successfully evaded capture by their unexpectedly rapid flight.



Figs. 3–5. *Ephuta s. slossonae*. 3, Frontal view of head, male. 4, Lateral view, female. 5, Dorsal view, female, right foretarsus showing rake along outer margin.

Searching behavior.—Females were frequently observed as they searched the sand in the area where *Episyron* nested. Five individuals were followed continuously for as

long as 35 minutes each. They walked steadily throughout the observation period, but in a highly erratic pattern, turning this way and that. The pattern seemed similar to the erratic path of a spider wasp searching for a suitable nesting site. No *Ephuta* that we followed were ever observed to locate a host nest successfully.

Ephuta females did, however, often locate and crawl inside the empty burrows excavated by female *Episyron.* One female *Ephuta* was observed as she searched a nesting area containing five empty burrows. An *Episyron* had just recently provisioned and closed her nest which was roughly surrounded by the empty burrows. The mutillid entered each of these open burrows remaining inside for 30-60 seconds. The sand grains surrounding the burrows also appeared to attract her as she often circled around the spoil heaps upon exiting. Four holes excavated by nesting ants were also present at this site. These too were inspected by the *Ephuta* which entered them but exited immediately.

At an adjacent nesting area, we disturbed an *Episyron* female just as she was in the final stages of closing her nest. In this area traversed by the spider wasp as she concealed her nest opening, we noted a female *E. s. slossonae* searching and showing interest in a small area of several cm^2. After a few minutes she began digging into the sand which she excavated with her forelegs, presumably using the weak tarsal rake (Fig. 5) to scratch the sand backward. As she dug, the loose sand above slid down covering her head and thorax. Her abdomen was still visible for a few seconds, and then she disappeared beneath the surface. She emerged in about 12 minutes at the spot where she had entered. She spent nearly a minute raking sand to conceal the small hole from which she had emerged. Interestingly, empty burrows of *Episyron* were not present around this nest.

We then dug up the nest and found the cell with the spider lying on its dorsal surface in damp sand at a depth of ca 7 cm. A wasp egg was not visible on the spider, so the paralyzed prey was placed in a vial of Kahle's solution for further study. Microscopic examination later revealed an oblique cluster of sand grains adhering to the spider's abdominal venter anterolaterally. When the grains were teased away, we found the collapsed and drained *Episyron* egg chorion. It seems probable that the egg had been punctured and fed upon by the *Ephuta.*

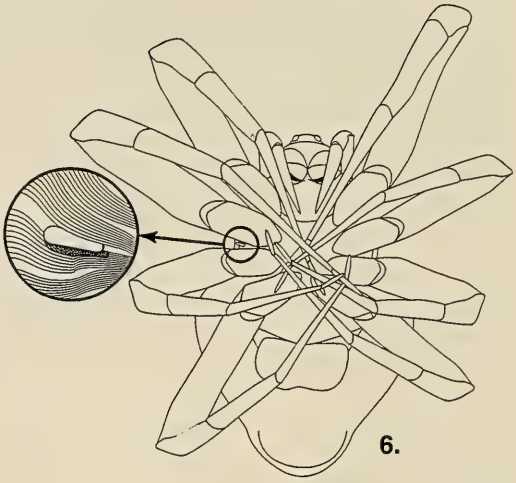


Fig. 6. *Eustala anastera.* Ventral view showing oviposition site on right side of cephalothorax, and, in circle, the egg of *Ephuta s. slossonae* between layers of muscle tissue.

No *Ephuta* egg was visible on the external surface of the spider. Careful dissection of the entire spider revealed a small, slightly curved *Ephuta* egg (ca 0.75 mm long) inserted between layers of muscle on the right side of the cephalothorax just above the second and third coxae (Fig. 6).

Discussion

These observations document the complex interaction between a spider wasp host and its mutillid parasite. The former, sometimes successfully, provides decoys, i.e. empty burrows, that divert the parasite from the nest. But occasionally, the parasite is successful in finding the nest. Presumably the parasite is guided to the nest entrance by scent of the host, and possibly also of the spider prey, remaining on particles of

Table 1. Taxa of *Ephuta,* their hosts, nest sites, and pertinent references. The taxa are grouped by nest types: 1–2, ground-nesting hosts; 3–5, mud cell hosts; 6, twig-nesting host.

Ephuta	Host	Nest Site	Reference
1. *slossonae* (Fox)	*Episyron posterus* (Fox)	sand	ibid.
2. *s. sabaliana* Schuster	? *Anoplius* (*Pompilinus*) *fraternus* (Banks)	salt flats	Krombein, 1979
3. *scrupea* (Say)	*Phanagenia bombycina* (Cresson)	cocoon of host (presumably in mud cell)	Schuster, 1951
4. *margueritae xanthocephala* Schuster	*Phanagenia bombycina* (Cresson) or *Auplopus* sp.	Hymenoptera—cocoons under stones (presumably in mud cells)	Schuster, 1951; Krombein, 1979
5. unidentified species from Panama	*Auplopus esmeralda* (Banks)	mud cell at base of inner surface of fallen palm frond	Kimsey, 1980
6. *p. pauxilla* (Bradley)	*Dipogon s. sayi* Banks	trap-nest	Evans and Yoshimoto, 1962

the substrate that are scattered about the area during nest closure.

Episyron.—Evans (1966) defined the term accessory burrows as "... any burrows started from the soil surface in close proximity to the true burrow and made by the same individual." Some species of *Episyron* make empty burrows more or less regularly, usually before construction of the nest, but sometimes afterward. What we recognize as empty burrows were reported in North America for *E. biguttatus* (Fabricius) (Peckham and Peckham 1898; Krombein 1953), *E. posterus* (Fox) (Kurczewski 1963, 1981; Kurczewski and Spofford 1986), and *E. quinquenotatus* (Say) (Peckham and Peckham 1898; Evans and Yoshimoto 1962). These observers reported that the empty burrows were dug before the nest burrow was excavated. None of them noted parasites at the nest sites.

We found that construction of empty burrows was common in the *E. posterus* population at the Lake Annie site. We also noted that empty burrows were usually made before completing the nest and were never used as a source of fill for nest closure. These empty burrows were not trial or test burrows such as those described by Kurczewski (1981) in his opening paragraph on *E. posterus.* Rather they appeared to be deliberate constructions in association with a nest burrow. Mutillids frequently walked into these empty burrows that usually were oriented in a direction differing from that of the nest burrow. We assume that empty burrows play some role in distracting and delaying parasites both during and following *Episyron* nesting.

Ephuta.—This is the first record of a mutillid probably feeding on the host egg, and then ovipositing within the body of the host's prey. This type of oviposition is reminiscent of the behavior of the cleptoparasitic pompilid, *Ceropales maculata* (Fabricius). Richards and Hamm (1939) reported the species as ovipositing within the stigmata leading to the lung-book of the spider. Other species of *Ceropales* are known to oviposit similarly.

Considering the oviposition behavior of *E. s. slossonae* in the context of similar behavior in the known species of *Ceropales* raises a question as to whether other species of *Ephuta* also oviposit within the spider prey of the host wasp. The few known or suspected hosts of *Ephuta* are limited to pompilid wasps[1]. Those few suspected

[1] In his listing of species of *Ephuta,* Fattig (1943: 13) mentioned that a male of *E. pauxilla* Bradley "... was taken with *Tiphia transversa* Say" [misspelled *transversata*]. The two specimens on a single pin are in the USNM collection. Both are males, so this odd coupling does not signify a possible host relationship as suggested by Schuster (1951: 14).

hosts of *Ephuta* are limited to pompilid wasps. Those few hosts have diverse nesting habits as noted in Table 1. Two species nest in the ground; three make mud nests in sheltered situations; and one nests in cavities in wood above ground.

Ephuta s. sabaliana Schuster is the other probable cleptoparasite of a ground-nesting spider wasp. The host is almost certainly *Anoplius (Pompilinus) fraternus* (Banks). Both species were observed in substantial numbers on the salt flats at Cape Sable, Florida (Evans, Krombein and Yoshimoto 1955; Krombein and Evans 1955). These observers found no other wasp or bee of appropriate size nesting in numbers in the ground. They noted no interaction between *Ephuta* and *Anoplius.* However, the *Anoplius* customarily left its spider prey on the ground while it searched for a nesting site, thus affording an opportunity for *Ephuta* to insert an egg into the spider.

Concerning the other four species of *Ephuta* listed in Table 1, apparently none of the cells was saved from which the mutillids emerged. This is unfortunate; the discovery of a mutillid cocoon *only* in the cells would have established that these species of *Ephuta* have oviposition behavior like that of *E. s. slossonae.*

Closer investigation of pompilids, their spider prey, and associated mutillids is clearly warranted. The available host information, though scanty, suggests that species of *Ephuta* are obligate cleptoparasites of Pompilidae (spider wasps).

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ISCHNODEMUS FALICUS (HETEROPTERA: LYGAEIDAE): FIRST RECORD FROM ORNAMENTAL GRASSES, AND SEASONALITY ON PRAIRIE CORDGRASS IN PENNSYLVANIA

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Abstract.—The blissine lygaeid *Ischnodemus falicus* (Say) is recorded for the first time as a pest of an ornamental grass. It infested prairie cordgrass. *Spartina pectinata* 'Aureomarginata,' in a Pennsylvania nursery, causing foliar chlorosis and occasionally a browning of blade apices. Seasonality of this univoltine bug in the nursery and in a nearby native colony of prairie cordgrass growing along a railroad was similar to that previously reported for Connecticut. Overwintered adults became active in early spring, began to mate by late May, egg hatch occurred by late June, and current-season adults appeared by late August or early September.

Key Words: Insecta, Heteroptera, Lygaeidae, prairie cordgrass, seasonality, Pennsylvania, monophagy

Ischnodemus falicus (Say) is a blissine lygaeid of elongate, dorsoventrally flattened habitus, an adaptation for living in leaf sheaths of grasses (Slater 1976). It has a wide distribution in North America, ranging from Quebec south to North Carolina and Louisiana, and west to South Dakota and Oklahoma (Ashlock and A. Slater 1988). This species has long been known to occur on grasses and sedges growing along ponds and lakes or in brackish areas near salt marshes (Torre-Bueno 1908, Blatchley 1926, Barber 1928). But almost 100 years elapsed from the original description (Say 1832) until a specific host was reported: prairie cordgrass, *Spartina pectinata* Link (Hendrickson 1930). Substantial biological information on *I. falicus* became available only with Harrington's (1972) report on seasonality of a population studied on prairie cordgrass in Connecticut; this bug was absent from nearby colonies of *S. alterniflora* Loisel or *S. patens* (Ait.) Muhl. Her paper also included incubation time and length of the nymphal stadia determined under laboratory conditions, and information on courtship, gregariousness, and other aspects of its biology.

In September 1989 my attention was called to an infestation of *I. falicus* in a 9-year-old planting of *S. pectinata* 'Aureomarginata' in a Pennsylvania nursery. Herein I record this lygaeid as a pest of ornamental prairie cordgrass and provide biological notes that allow comparison with the results of field studies in Connecticut (Harrington 1972).

Study Sites and Methods

Biological observations were made at two sites in Centre Co., Pa.: a nursery (in Halfmoon Twp.) specializing in ornamental grasses, and a nearby small colony of prairie cordgrass growing in ballast along the railroad that parallels Route 220 (Huston Twp., c. 5 km from the nursery). Periodic

collections from one or both plantings were made in 1989 (6 & 21 Sept., 27 Oct.), 1990 (22 Mar., 27 Apr., 7 May, 1 & 21 June, 19 July, 23 Aug., 16 Sept.), 1991 (7 Apr., 20 May, 29 June, 31 July, 5 Oct.), 1993 (29 Sept.) and 1995 (6 & 15 June). On each visit, stems of *S. pectinata* were tapped over a white tray to dislodge the bugs from leaf sheaths. When nymphs were present, a small sample (usually at least 10) was collected, preserved in 70% ethanol, and the stages determined in the laboratory.

Results and Discussion

Ischnodemus falicus has not previously been accorded economic importance, although this lygaeid has been collected with chinch bugs, *Blissus leucopterus* (Say), on corn (Froeschner 1944). It has also been recorded as a minor household nuisance: swarming about houses during November in North Carolina (Farrier 1958) and congregating on houses along a stream in Connecticut (D. E. Leonard *in* Harrington 1972). The present paper gives the first record of its occurrence on an ornamental grass.

In August 1989 thousands of nymphs and adults infested prairie cordgrass, aggregating on plants in a row about 45 m long × 4 m wide and causing foliar chlorosis. Severely infested blades were brown at the tips. When the foliage was parted or the bugs otherwise disturbed, a "buggy" odor was immediately apparent. Similarly a delicate brushing of the grass host of *I. quadrispinosus* Slater in South Africa immediately caused the bugs to emit a "scent odor," suggesting that this lygaeid affords its host some protection from grazing by ungulate herbivores (Slater and Wilcox 1973).

Seasonality of *I. falicus* populations in the nursery and along the railroad right-of-way was similar. Overwintered adults aggregated within leaf sheaths at the base of last season's *S. pectinata* stems that were sprawling on the ground. In early spring, after the row of ornamental prairie cordgrass had been burned, adults were found at the base of charred stems and in cracks in the soil. Mating pairs (Fig. 1) were observed on new host growth as early as 20 May, but first instars were not seen until late June. During weekly sampling in Connecticut, first instars were not present until the last week of June (Harrington 1972).

By mid-July, only first and second instars were present in the Pennsylvania populations of *I. falicus*. Mating took place as late as mid-July, and first instars could be found until mid-August. At this time, the population consisted mainly of third through fifth instars. Adults of the new generation first appeared in late August to early September. In 1991, no nymphs were observed in early October, but in 1989 they were present in late October. Nymphs apparently do not survive the winter, as noted by Harrington (1972), and only a single generation is produced.

Biological observations on *I. falicus* in Pennsylvania, while not as thorough as those of Harrington (1972) in Connecticut, were similar. This species is a gregarious feeder within leaf sheaths of *S. pectinata,* its principal and apparent sole breeding host. It can be considered a minor pest of *S. pectinata* 'Aureo-marginata,' a cultivar having shiny green leaves and yellow marginal stripes (Ottesen 1989, Still 1994). The bug was common in the nursery each season of observation, despite an annual burning of its host plant in spring. *Ischnodemus falicus* did not infest any of the other ornamental grasses grown in the Pennsylvania nursery, including species of *Arrehenatherum, Bouteloua, Calamagrostis, Deschampsia, Elymus, Festuca, Miscanthus, Molinia, Panicum, Pennisetum, Phalaris,* and *Sisyrinchium.*

This lygaeid can be found in native colonies of *S. pectinata* growing under both wet and dry conditions, ranging from salt marshes and freshwater habitats to ballast along railroads. Pure stands of prairie cordgrass once covered large areas of Missouri River bottomland and were present

Fig. 1. Mating pair of *Ischnodemus falicus* on prairie cordgrass.

throughout the tallgrass prairie before the land was placed in agriculture or drained (Brown 1979, DeSelm 1986). Although this plant is stated to occur primarily in swamps and wet prairies and is still found in wetlands within the tallgrass prairie ecosystem (Johnson 1995), its principal habitat in the Midwest is now open dry prairie or high ground along roadsides or railroad rights-of-way (Mobberley 1956, Holder 1990). The bug indeed colonizes prairie cordgrass in such situations in the Midwest. I found adults on this host along the railroad at New Ulm (Nicollet Co.), Minn. (new state record), in June 1995 (see also Holder 1990).

The Pennsylvania occurrence of *I. falicus* in a colony of prairie cordgrass growing in railroad ballast is the first record from such a dry habitat in the East. Previous records have involved either salt- or freshwater habitats. Harrington (1972) commented on the need for a humid immediate environment, noting that eggs and early instars are particularly vulnerable to desiccation in the field when host grasses become too dry. The prairie cordgrass colony occurring along the railroad in Pennsylvania always maintained a sprawling growth habit, which may have provided the bugs with more moist conditions than an erect or upright-arching growth of the host. The dense nursery planting may have afforded a similar environment.

Blissine lygaeids develop only on monocotyledonous plants, and most species are restricted to one or a few closely related hosts (Slater 1976). *Ischnodemus falicus* appears to develop only on prairie cordgrass. It also is a relatively late-season univoltine bug, whose development in the laboratory from egg to adult requires about two months. In the field, oviposition does not begin until about early June, and current-season adults do not appear until late August or early September.

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A REVIEW OF THE GENUS *CHRYSOTUS* (DIPTERA: DOLICHOPODIDAE) FROM BERMUDA

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Abstract.—The four species of the genus *Chrysotus* (Diptera: Dolichopodidae) found in Bermuda are taxonomically reviewed. ***Chrysotus hilburni,* new species** is described, males of *C. bermudensis* Johnson are described for the first time, and *C. magnipalpus* Van Duzee, 1927 is a **new synonym** of *C. crosbyi* Van Duzee, 1924.

Key Words: Diptera, Dolichopodidae, *Chrysotus,* Bermuda

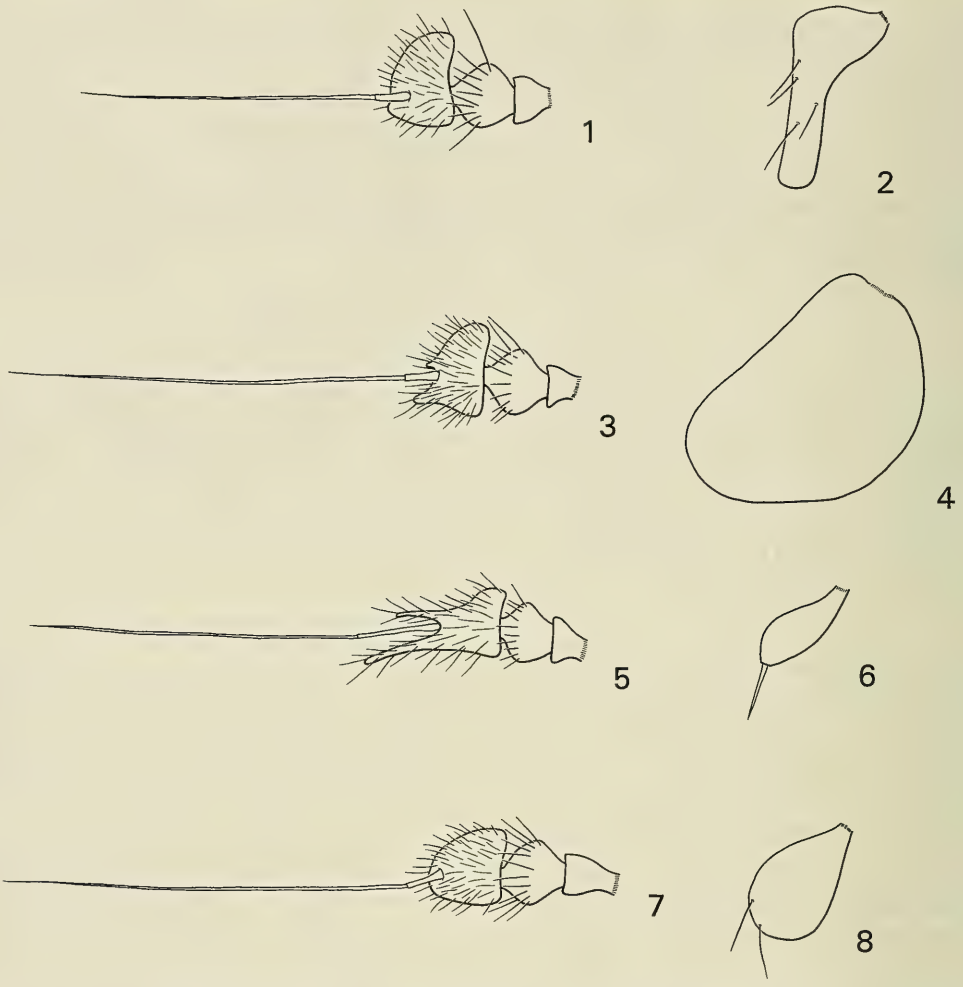
In a survey of the Diptera of Bermuda (Woodley and Hilburn 1994), species associated with aquatic and marine littoral habitats were a significant component of the fly fauna, an observation not surprising for a small oceanic island archipelago with little topography. The Dolichopodidae, with the vast majority of its species being associated with water habitats, were the fifth most speciose family of flies in Bermuda, with 12 genera and 15 species recorded. Four of these belonged to the genus *Chrysotus* Meigen. Two are believed to be endemic, one of which is undescribed. The other, *Chrysotus bermudensis* Johnson, was known only from females prior to this study. Thus, a brief review of the genus for Bermuda seems warranted to characterize taxonomically the poorly known species that occur there.

Chrysotus is a large genus of at least 270 species found worldwide. Because individuals are small in size and usually rather plain morphologically compared to many other dolichopodids (especially the females), the genus has been relatively neglected. There are certain to be many undescribed species, especially in the Neotropical Region. The taxonomy of the genus has been based mainly on easily visible external morphology, without critical study of the male genitalia, which are largely retracted within the abdomen.

The excellent key to Nearctic genera of Dolichopodidae in Volume 1 of the *Manual of Nearctic Diptera* (Robinson and Vockeroth 1981) works well for the known Bermudan fauna. Most of the non-*Chrysotus* dolichopodid species can easily be identified using Robinson's (1964) synopsis of the fauna of southeastern North America.

KEY TO SPECIES OF *CHRYSOTUS* IN BERMUDA

1. All coxae pale yellow, concolorous with femora and tibiae; females with katepisternum and meron largely yellow; male antenna with basal flagellomere with deep apical notch in which the arista is inserted (Fig. 5) . . . . . *C. hilburni,* **new species**
– Middle and hind coxae dark, contrasting with pale yellow femora; females with katepisternum and meron dark; male antenna with at most a shallow apical notch (Fig. 3) 2
2. Middle tibia with only a single anterodorsal bristle near basal fourth; abdominal tergites dark brown to black, sometimes with faint bluish metallic reflections; male palpi greatly enlarged, flap-like, bright silvery white (Fig. 4) . . . . . *C. crosbyi* Van Duzee



Figs. 1–8. Male antennae of *Chrysotus* spp., lateral views. 1, *C. bermudensis.* 3, *C. crosbyi.* 5, *C. hilburni.* 7, *C. picticornis.* Male palpi of *Chrysotus* spp., lateral views. 2, *C. bermudensis.* 4, *C. crosbyi.* 6, *C. hilburni.* 8, *C. picticornis.*

– Middle tibia with one anterodorsal and/or one posterodorsal bristle near middle; abdominal tergites distinctly metallic green to bronzy; male palpi not greatly enlarged, at most with a projecting apex, white to yellowish, not silvery 3

3. First antennal segment yellow; male fore femur with row of uniform, ventrally directed setae on posterior face, much longer than general vestiture; male palpus small, rounded, about as wide as long (Fig. 8); scutum and abdomen generally with distinct coppery reflections, more tomentose (less shiny) than *C. bermudensis* . . . . . .*C. picticornis* Loew

– First antennal segment black; male front femur without differentiated row of setae on posterior face, at most one or two enlarged setae near apex; male palpus with long, parallel-sided apex more than twice as long as wide (Fig. 2); scutum and abdomen dark metallic green, less tomentose (more shiny) than *C. picticornis* . . . . . *C. bermudensis* Johnson

Chrysotus bermudensis Johnson
(Figs. 1, 2, 9)

Chrysotus bermudensis Johnson, 1913: 446. Holotype ♀: Bermuda (MCZ, examined).

Diagnostic description.—*Male:* Head with frons metallic green, in some speci-

mens with faint bluish reflections, moderately shiny; eyes contiguous on face; setae of head black, except postocular row yellow on lower two-thirds; antenna (Fig. 1) black, first flagellomere wider than long, apex sharply rounded, arista inserted slightly lateral to and above apex; palpus (Fig. 2) whitish yellow, apex slightly darker yellow, sharply tapered near base to parallel-sided apical region that is more than twice as long as wide, apex rounded. Thorax with scutum bright green, with slight coppery reflections in some specimens, thinly tomentose, pleura dark and more densely tomentose; scutal setae black, acrostichals biserial; scutellum with one strong pair of marginal setae, with one hair-like pair lateral to these. Legs with front coxae except extreme bases pale yellow, with yellow setae, mid and hind coxae dark; remainder of legs pale yellow except apical third to fourth of hind femur black, and all tarsi slightly darkened apically; front femur with two to four slightly enlarged posteroventral setae near apex, otherwise with uniform vestiture, hind femur with two or three enlarged anteroventral setae near apex; midtibia with one anterodorsal seta near base and one anterodorsal and one posterodorsal seta near middle (the anterior of these usually larger); tarsi unmodified. Wing with costal border of cell r_1 2.0 times length of costal border of cell c; anal lobe evenly rounded; vein A_2 faint, fold-like; calypter pale with pale yellow setae; halter pale yellow, stem vaguely darker. Abdomen green (concolorous with scutum), shiny with almost imperceptible tomentum, setae black. Male terminalia (Fig. 9) with hypandrial lobe short, triangular; epandrial lobe short, broad, rounded apically; surstyli robust, slightly arcuate, apices convergent, each with a strong, peg-like seta and sharp internal angle, appearing bifurcate; cercus small, nearly triangular in outline. Length 1.3–1.9 mm.

Female: Differs from male as follows: Head with eyes separated by face which is nearly parallel-sided, with dense gray tomentum; antenna with basal flagellomere a little shorter than in male; palpus simple, ovoid, grayish with indistinctly yellower margins. Length 1.5–2.3 mm.

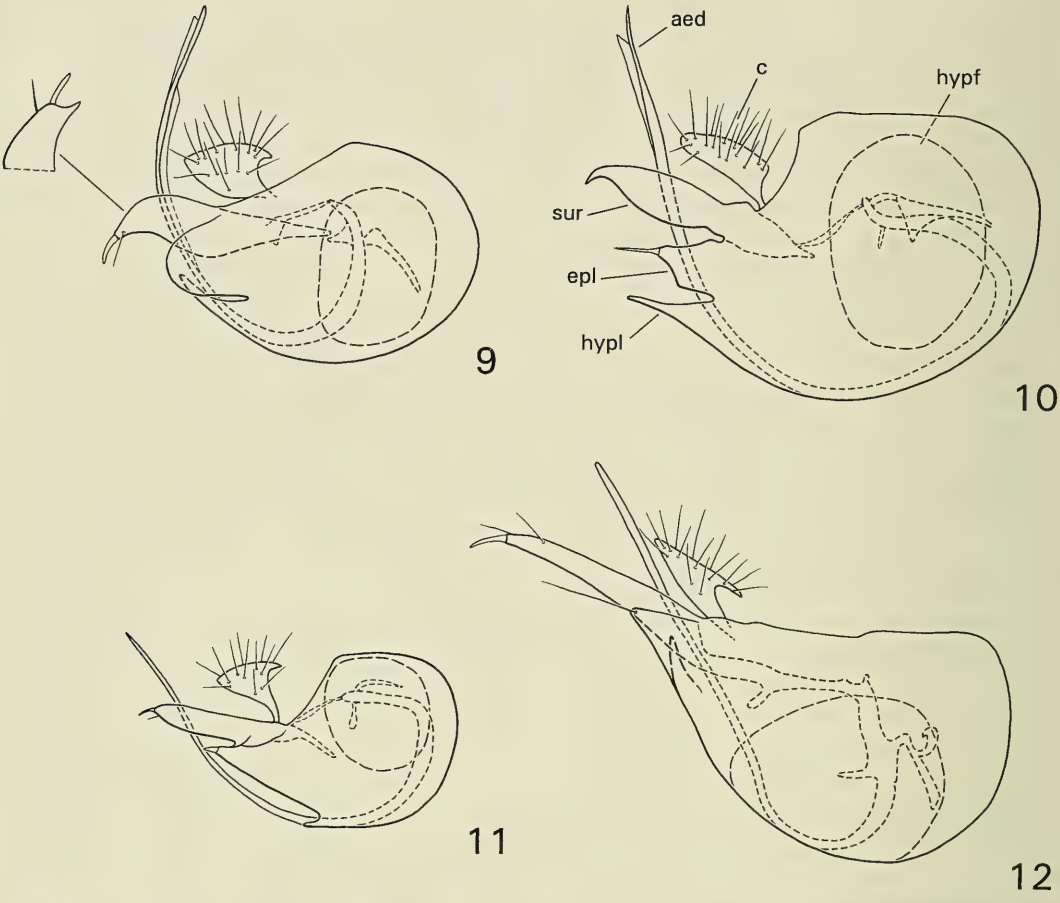
Distribution.—Known only from Bermuda.

Specimens examined.—BERMUDA: 1 ♀ (holotype), 26.vii.1905, T. K[incaid] (MCZ); 2 ♀ (paratypes), 30.vi.1905, T. K[incaid] (MCZ); 4 ♂, 1 ♀, St. Georges, 1-3.ii.1934, A. L. Melander (USNM); 2 ♂, Smith's Parish, Spittal Pond, Malaise trap, 7.viii.1987, D. J. Hilburn (BNHM); 1 ♂, 3 ♀, same data but 12.viii.1987 (BNHM); 2 ♀, Smith's Parish, Spittal Pond, sweeping pond edge, 18.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 1 ♀, Hamilton Parish, Shelly Bay, sweeping at edge of mangroves, 20.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 1 ♂ same data, 31.v.1991, N. E. Woodley (USNM); 1 ♀, Southampton Parish Horseshoe Bay, 15.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 1 ♂, Paget Parish, Malaise trap, 15.x.1987, D. J. Hilburn (BNHM); 1 ♂, Paget Parish, Paget Marsh, 15.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 1 ♀, same data, 3.vi.1991, N. E. Woodley (USNM); 6 ♂, 11 ♀, Devonshire Parish, Devonshire Marsh, sweeping near water, 20.xi.1987, D. J. Hilburn, N. E. Woodley (BNHM, USNM); 2 ♂, 2 ♀, same data, 30.v.1991, N. E. Woodley (USNM); 5 ♂, 1 ♀, Warwick Parish, Warwick Pond, 3.vi.1991, N. E. Woodley (USNM).

Biology.—This species has been collected in typical wetland habitats that dolichopodids frequent, especially pond margins and marshes. It was also collected in a mangrove swamp.

Remarks.—In citing the type material Johnson (1913) stated that the dates of collection were "June 20, July 26." The holotype label is dated July 26, but the two paratypes are dated June 30. This was probably a typographical error in Johnson's paper as the types were clearly labeled by Johnson.

Chrysotus bermudensis keys to *C. annulatus* Van Duzee (known from the eastern seaboard of the U.S., from Connecticut



Figs. 9–12. Male hypopygia of *Chrysotus* spp., lateral views. 9, *C. bermudensis,* with inset showing dorsal view of surstylus. 10, *C. crosbyi.* 11, *C. hilburni.* 12, *C. picticornis.* Abbreviations: *aed,* aedeagus; *c,* cercus; *epl,* epandrial lobe; *hypf,* hypopygial foramen; *hypl,* hypandrial lobe; *sur,* surstylus.

south to Florida) in Robinson's (1964) key to species from eastern North America. Males of *C. annulatus* have an ovoid palpus with a single conspicuous apical seta, and very different terminalia with elongate thorn-like surstyli and elongate cerci.

This species usually has a bright, shiny green appearance, but some specimens may have coppery reflections. As with metallic coloration in other insects, some variation is probably the result of differences in conditions as individual specimens dry after death. Also, care must be taken in observing setal color, as pale setae often appear black in certain lights.

Chrysotus crosbyi Van Duzee
(Figs. 3, 4, 10)

Chrysotus crosbyi Van Duzee, 1924: 43. Holotype ♂: USA, Missouri, "Columbus" [sic; label reads Columbia] (CORN, examined).

Chrysotus magnipalpus Van Duzee, 1927: 2. Holotype ♂: Cuba, Havana (AMNH, examined). **New Synonymy.**

Diagnostic description.—*Male:* Head with frons dark metallic violet, with faint greenish or bronzy reflections in some specimens, moderately shiny; eyes nearly contiguous on face, face narrower medially

than the diameter of an adjacent ommatidium; setae of head black, except some of postocular row yellow on lower half; antenna (Fig. 3) black, first flagellomere broader than long, apex slightly notched, arista inserted at base of notch; palpus (Fig. 4) enlarged, bright silvery white, nearly ovoid, margins broadly rounded. Thorax with scutum dark bronzy green, thinly tomentose, scutellum a little more bluish in most specimens; pleura dark and more densely tomentose; scutal setae black, acrostichals biserial; scutellum with one strong pair of marginal setae, with one small, hair-like pair lateral to these. Legs with front coxae yellowish with some irregular dark obfuscation, usually contrasting to the more uniformly darkened mid and hind coxae, with mostly dark setae; remainder of legs yellowish except dorsal surfaces of femora and apex of hind femur may be nebulously darkened in some specimens; front femur with one slightly enlarged posteroventral seta near apex, otherwise with uniform vestiture, hind femur with two or three enlarged anteroventral setae near apex; middle tibia with one anterodorsal seta near basal third, none near middle; tarsi unmodified. Wing with costal border of cell r_1 1.9–2.0 times length of costal border of cell c; anal lobe evenly rounded; vein A_2 present only near base as a faint fold; calypter dark with dark yellow setae; halter pale yellow, stem vaguely darker. Abdomen dark brown to black with vague metallic blue to violet reflections, very thinly tomentose, setae black. Male terminalia (Fig. 10) with hypandrial lobe short, triangular; epandrial lobe short, broad, abruptly tapered to apex, with a stout apical seta; surstyli robust, slightly arcuate, apices convergent and each tapered to a sharp apex; cercus small, long ovoid with a squarish angle near base. Length 1.2–1.5 mm.

Female: Differs from male as follows: Head with frons tending to be more bluish than in male; eyes separated by face which has margins convergent to medial transverse ridge, then slightly divergent, with dense gray tomentum covering evident bluish metallic coloration; antenna with basal flagellomere a little shorter than in male, much more shallowly notched; palpus much smaller than in male, simple, ovoid, dark. Front coxae sometimes more conspicuously yellow than in male. Length 1.3–1.7 mm.

Distribution.—Known from the Eastern United States (Georgia, Missouri, North Carolina), Bermuda, Cuba, and Puerto Rico. Robinson (1977) has seen specimens from Brazil that are possibly conspecific.

Specimens examined.—BERMUDA: 22 ♂, 14 ♀, Devonshire Parish, Devonshire Marsh, sweeping near water, 20.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 8 ♂, same data, 30.v.1991, N. E. Woodley (USNM); 2 ♂, 13 ♀, Smith's Parish, Spittal Pond, sweeping pond edge, 18.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 6 ♂, 7 ♀, Hamilton Parish, Shelly Bay Beach, 31.v.1991, N. E. Woodley (USNM); 10 ♂, 3 ♀, Paget Parish, Paget Marsh, 3.vi.1991, N. E. Woodley (USNM); 1 ♂, Hamilton Parish, Walsingham Bay, 31.vi.1991, W. N. Mathis (USNM); 1 ♂, 1 ♀, Warwick Parish, Warwick Pond, 3.vi.1991, N. E. Woodley (USNM). Additional specimens from Bermuda were examined from BNHM that were previously recorded as *C. magnipalpus* (Woodley and Hilburn 1994: 23). Also, 2 ♂, UNITED STATES: North Carolina, Durham Co., 25.v.1960, H. Robinson (HRC).

Biology.—This species is quite common in freshwater marsh and pond habitats, and some specimens were collected in the mangrove swamp at Shelly Bay.

Remarks.—I initially identified this species as *Chrysotus magnipalpus* (Woodley and Hilburn 1994) because Bermuda specimens tend to have fore coxae that are paler than the posterior two pairs, sometimes quite yellow in females. Thus, they do not fit couplet 9 in Robinson's (1964) key very well. Additionally, no mention is made in the key of the unique form of the palpi, only that they are "enlarged, nearly as long

as height of face" (Robinson 1964: 131). I matched the Bermuda material to a specimen in the USNM identified as *C. magnipalpus* from Puerto Rico, and confirmed its identity by examining the holotype. Van Duzee (1927: 2) described the fore coxae of *C. magnipalpus* as "mostly yellow." At that time I made the mistaken assumption that Van Duzee would not have described the same species twice in the space of three years. However, I recently examined material of *C. crosbyi,* including its holotype, and found them to be conspecific with *C. magnipalpus.* It seems that for some widespread dolichopodids some color features are variable and therefore unreliable for keys, such as coxal color in this species. Color variation was also found in Bermudan material of *Diaphorus contiguus* Aldrich (Woodley and Hilburn 1994), which would not key out properly in Robinson's (1964) key to that genus.

Chrysotus hilburni Woodley, New Species
(Figs. 5, 6, 11)

Diagnostic description.—*Male:* Head with frons metallic green, thinly tomentose, moderately shiny; eyes nearly contiguous on face, medial part of face much narrower than an adjacent ommatidium; setae of head black, except postocular row yellow on lower half; antenna (Fig. 5) with scape and pedicel yellow, flagellum dark, first flagellomere longer than high, apex deeply notched, arista inserted at base of notch; palpus (Fig. 6) whitish yellow, slightly club-shaped, apex with single, long, stout seta. Thorax with scutum bright green, with slight coppery reflections in most specimens, thinly tomentose, scutellum more bluish in most specimens; pleura yellowish brown, non-metallic and more densely tomentose; scutal setae brownish, acrostichals biserial; scutellum with one strong pair of marginal setae, without hair-like pair lateral to these. Legs including coxae entirely pale yellow, tarsi with apical tarsomere slightly darkened; femoral and tibial setae primarily yellow; front femur with two or three slightly enlarged posteroventral setae near apex, otherwise with uniform vestiture, hind femur with two or three enlarged anteroventral setae near apex; middle tibia with only one anterodorsal seta on basal third; tarsi unmodified. Wing with costal border of cell r_1 2.1–2.3 times length of costal border of cell c; anal lobe evenly rounded; vein A_2 faint, present only as a weak fold; calypter pale with pale yellow setae; halter pale yellow. Abdomen brownish, with faint green metallic reflections, weakly shiny with inconspicuous tomentum, setae dark. Male terminalia (Fig. 11) with hypandrial lobe extremely short, triangular; epandrial lobe very short, bluntly rounded apically, with short, stout apical seta; surstyli with inner margins expanded, apices nearly parallel in dorsal view, each with one or two tiny subapical setae and short, stout, slightly curved apical seta; cercus small, nearly triangular in outline. Length 1.1–1.3 mm.

Female: Differs from male as follows: Head with eyes separated by face which has convergent margins in upper half, nearly parallel-sided in lower half, with dense gray tomentum; antenna with basal flagellomere shorter than in male, only shallowly notched; palpus simple, ovoid, yellow. Thorax with lower parts of pleura pale yellow. Abdomen with sternites pale yellow. Length 1.2–1.6 mm.

Distribution.—Known only from Bermuda.

Specimens examined.—BERMUDA: Holotype ♂, allotype ♀, 4 ♂, 2 ♀ paratypes, Devonshire Parish, Devonshire Marsh, sweeping near water, 20.xi.1987, D. J. Hilburn, N. E. Woodley (USNM). Additional paratypes: 3 ♂, 7 ♀, same data, 30.v.1991, N. E. Woodley (USNM, BNHM, CNC); 2 ♂, 2 ♀, Hamilton Parish, Trott's Pond, in grass, 29.xi.1966 (BNHM); 7 ♂, 9 ♀, Paget Parish, Paget Marsh, 3.vi.1991, N. E. Woodley (USNM, BNHM, CNC).

Biology.—This species has been taken only at marshy habitats in Bermuda. It

seems to be the least common species of *Chrysotus* on the islands.

Remarks.—*Chrysotus hilburni* is quite similar to *C. furcatus* Robinson from the eastern United States (Iowa and New York south to Florida) but differs in a number of respects. In *C. furcatus* the frons is bluish to violet in both sexes; the basal antennal flagellomere in the male has the lobes beyond the notch much more dissimilar in length, the lower being much longer than the upper; and the pleura of the female are completely dark. The male genitalia of *C. hilburni* differ from those of *C. furcatus* by having a very short hypandrium and straighter, more slender surstyli (viewed laterally). The male palpi in the two species are very similar, with a characteristic apical seta. This may be a synapomorphy for a subgroup of *Chrysotus* that includes these two species, *C. annulatus,* and probably others.

I take much pleasure in naming this species after Daniel J. Hilburn. While appointed as Plant Protection Officer in Bermuda he initiated a modern faunal survey of the islands that resulted in a much greater understanding of the insects inhabiting this oceanic archipelago.

Chrysotus picticornis Loew
(Figs. 7, 8, 12)

Chrysotus picticornis Loew, 1862: 214. Type(s) ♂: USA, Illinois (MCZ, not examined).

Diagnostic description.—*Male:* Head with frons metallic cupreous green, finely shagreened so as to appear only weakly shiny; eyes nearly contiguous on face, face extremely narrow medially, much less than the width of an adjacent ommatidium; setae of head black, except postocular row yellowish white on lower two-thirds or more; antenna (Fig. 7) with scape and basal part of pedicel yellow, sometimes lower basal angle of first flagellomere yellowish, remainder black; first flagellomere about as long as high, apex rounded, arista inserted slightly lateral to the apex; palpus (Fig. 8) pale yellow, small ovoid, with two or three small marginal setae near apex. Thorax with scutum cupreous green, moderately tomentose, pleura dark and densely tomentose; scutal setae black, acrostichals biserial; scutellum with one strong pair of marginal setae, with one hair-like pair lateral to these. Legs with front coxae yellow, with yellow setae, mid and hind coxae dark; remainder of legs yellow except apical fourth of hind femur darkened, and all tarsi becoming darkened apically; front femur with posteroventral row of uniform setae, pale basally becoming dark and stouter near middle and continuing to apex; hind femur with row of three to five enlarged anteroventral setae apically and some denser pale pubescence at basal third; middle tibia with one anterodorsal seta near base and one anterodorsal and one posterodorsal seta near middle; tarsi unmodified. Wing with costal border of cell r_1 2.1–2.3 times length of costal border of cell c; anal lobe more developed than in other Bermuda species; vein A_2 well delineated on basal half; calypter pale with brownish setae; halter yellow. Abdomen cupreous green (concolorous with scutum), sheen dulled by thin tomentum, setae black. Male terminalia (Fig. 12) with hypandrial lobe short, triangular; epandrial lobe short, broad, triangular apically in lateral view, with long apical seta; surstyli elongate, slender, apices divergent, each with two or three small subapical setae and short, stout slightly curved apical seta; cercus small, nearly triangular in outline. Length 1.4–2.1 mm.

Female: Differs from male as follows: Head with eyes separated by face which is nearly parallel-sided, with dense brownish gray tomentum; antenna with basal flagellomere a little shorter than in male; palpus simple, ovoid, dirty yellowish. Front femur without posteroventral row of setae, only two or three enlarged setae near apex; hind femur with shorter, more uniform vestiture. Length 1.5–2.1 mm.

Distribution.—Widespread in the United

States from Massachusetts south to California and Florida, and Mexico (Chiapas). Other Neotropical records probably refer to other species (Robinson, 1967).

Specimens examined.—BERMUDA: 6 ♂, 4 ♀, Smith's Parish, Spittal Pond, sweeping pond edge, 18.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 1 ♂, same data, 29.v.1991, N. E. Woodley (USNM); 1 ♂, 6 ♀, Hamilton Parish, Shelly Bay, sweeping at edge of mangroves, 20.x.1987, D. J. Hilburn, N. E. Woodley (USNM); 2 ♂, 5 ♀, Devonshire Parish, Devonshire Marsh, sweeping near water, 20.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 36 ♂, 30 ♀, same data, 30.v.1991, N. E. Woodley (USNM); 12 ♂, 2 ♀, Devonshire Parish, Cloverdale, 29.v.1991, W. N. Mathis (USNM); 3 ♂, 2 ♀, Devonshire Parish, Outerlea Farm, 2.vi.1991, W. N. Mathis (USNM); 2 ♂, 1 ♀, Paget Parish, Paget Marsh, 15.xi.1987, D. J. Hilburn, N. E. Woodley (USNM); 8 ♂, 6 ♀, same data, 3.vi.1991, N. E. Woodley (USNM); 1 ♂, Paget Parish, Hungry Bay, beach, 2.vi.1991, W. N. Mathis (USNM); 8 ♂, 14 ♀, Warwick Parish, Warwick Pond, 3.vi.1991, N. E. Woodley (USNM). Additional Bermuda material has been examined that is now in BNHM and MCZ (Woodley and Hilburn 1994). Also, extralimital material of *C. picticornis* was examined in the USNM collection.

Biology.—In my experience this is the most common species of *Chrysotus* in Bermuda. It is frequent virtually everywhere there is pond or marshy habitat, as well as in mangrove areas.

Remarks.—Robinson (1967) found that what had been called *C. picticornis* from Neotropical localities was actually a complex of three species. He cited variation in the hypopygial morphology of one of the similar species, *C. mexicanus* Robinson, so it is quite possible that even more species are involved. The Bermuda material clearly conforms to Robinson's concept of *C. picticornis* with its distinctive vestiture of the hind femur and hypopygial structure. This species is easily identifiable using Robinson's (1964) key.

Acknowledgments

I thank once again all those persons cited in Woodley and Hilburn (1994) for facilitating the study of the Diptera of Bermuda. Dan Hilburn also energetically facilitated my work on Bermuda flies in many ways. I wish to thank the Bermuda Natural History Museum (BNHM); Jeffrey Cumming, Canadian National Collection, Agriculture Canada (CNC); David Furth, Museum of Comparative Zoology, Harvard University (MCZ); David Grimaldi, American Museum of Natural History (AMNH); and E. R. Hoebeke, Cornell University Insect Collection (CORN) for loaning holotypes and other material important to this study. Other specimens are in the National Museum of Natural History, Smithsonian Institution (USNM). Harold Robinson provided valuable discussion about some of the species discussed in this paper, loaned material from his collection (HRC), and critically read the manuscript. I also thank Brian Brown, Wayne Mathis, Allen L. Norrbom, and David R. Smith for reviewing the manuscript.

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XEROTHRIPS DISSIMILIS NEW GENUS AND SPECIES (THYSANOPTERA: THRIPIDAE) FROM CALIFORNIA AND NEVADA

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Abstract.—A new genus ***Xerothrips*** and new species ***dissimilis*** are described from California and Nevada. An unusual internal gland in abdominal segment III of the males of *dissimilis* and a similar gland previously reported in other species are discussed.

Key Words: Thysanoptera, Thripidae, *Xerothrips, dissimilis,* internal gland

Xerothrips dissimilis new genus and species is known from the Mohave Desert of California and Nevada, and in the central valley of California. This monotypic genus is closely related to *Baileyothrips* which occur in the southwestern states. The females are macropterous and brachypterous and the known males are brachypterous. Although collected from several plants grown commercially, *X. dissimilis* is not known to be a pest.

Males of many species in the family Thripidae bear glandular structures of various shapes (circular, elliptical, transversely elongate and usually narrowed medially, v-shaped, c-shaped) on abdominal sternites III-VII and known in the literature as "glandular areas" or "areae porosae." Males of *Xerothrips dissimilis,* new species, lack glandular areas but have an unusual internal gland in abdominal segment III that opens through a small circular orifice near the anterior margin of the sternite (Fig. 9). A similar gland reported previously in another species is associated with a glandular area also on abdominal sternite III. The gland in males of *Baileyothrips arizonensis* (Morgan) illustrated by Kono and O'Neill (1964) opens through an orifice on the anterior part of an elliptical, reticulated glandular area located on the anterior part of the sternite. A similar glandular area was also observed in a male of *B. limbatus* (Hood). Males of *Pseudothrips beckhami* Beshear and Howell and *P. inequalis* (Beach) have a reticulated glandular area similar to that of *Baileyothrips* and a small, slightly tuberculated area with an protruding orifice in front of the glandular area (Beshear and Howell 1976), thus indicating that a internal gland is present. The internal gland was visible only in cleared and stained males. Because thrips are not normally stained, the gland could be present in other species.

Acronyms of depositories of type specimens are as follows: CAS = California Academy of Sciences, San Francisco; CDFA = California Department of Food and Agriculture, Sacramento; FSCA = Florida State Collection of Arthropods, Gainesville; INHS = Illinois Natural History Survey, Champaign; NHM = Natural History Museum, London, United Kingdom; SMF = Forschungsinstitut Naturmuseum Senckenberg, Frankfurt am Main, Germany; UCD = University of California, Davis; UCR = University of California, Riverside; USNM = United States National Museum of Natural History, Washington DC.

Xerothrips Nakahara, New Genus

Type species.—*Xerothrips dissimilis,* new species.

Female: Antenna 8-segmented, segments III and IV with forked trichomes, trichome on outer apical margin on III often appearing simple, that on IV ventral and forked. Head with 3 ocelli; 3 pairs of ocellar setae; 2 pairs of postocular setae between posterior part of eyes; eyes with 6 pigmented facets; maxillary palpi 3-segmented. Legs with 2 segmented tarsi. Pronotum rectangular; with 1 pair of well developed posteroangular setae; occasional macroptera with additional developed, outer posteroangular setae. Mesonotum with submedian setae slightly caudad of lateral setae. Mesosternal spinula weakly developed. Brachyptera with short, oval forewings with a few marginal and veinal setae; macroptera with two complete rows of veinal setae, anterior and posterior fringe cilia straight. Abdomen with median setae long on tergites II–VIII, close-set on tergite II and succeedingly longer and farther apart posteriorly; posteromarginal flange absent; ctenidia absent; tergite VIII with well developed posteromarginal comb. Sternites III-VII with discal setae and each with 3 pairs of posteromarginal setae.

Male: Abdominal tergite IX with bristle-like setae; sternites without glandular areas; segment III with internal gland (Fig. 9).

Etymology.—Generic epithet is a combination of the Greek "Xero" (dry) and the common name of order "thrips." This genus is known from the Mohave Desert and central valley of California.

Comments.—Brachyptera and macroptera closely resemble the two members of *Baileyothrips, arizonensis* (Morgan) and *limbatus* (Hood), in having 8-segmented antennae, two pairs of postocular setae between posterior margin of eyes, six pigmented facets on each eye, forewing with fringe cilia straight, long median pair of tergal setae on abdomen, additional discal setae on posteromargins of sternites, and the males with a internal gland in abdominal segment III. The two genera differ as follows. In *Xerothrips,* at least one pair of pronotal posteroangular setae is present; forewing of macroptera has two complete rows of veinal setae, and the costal setae are as long as the width of wing at midlength; abdominal tergites lack a posteromarginal flange; and small discal setae are present on the pleurotergites. The gland in abdominal segment III of males opens in a small orifice in a slightly differentiated area on anterior medial part of the sternite (Fig. 9). In *Baileyothrips,* the pronotum lacks developed posteroangular setae; forewing has short, intermittent setae on the distal half of the forevein, and short costal setae are about ¼ as long as width of wing at midlength; abdominal tergites each have a posteromarginal flange with teeth laterally; and pleurotergites lack discal setae. The gland in abdominal segment III of males opens into a orifice at the anterior part of an elliptical, reticulated glandular area on the sternite (Kono and O'Neill 1964).

Xerothrips will run to *Oxythrips* in couplet 34 of the generic key in "The Thrips of Illinois" by Stannard (1968:275). *Xerothrips* has a posteromarginal comb on abdominal tergite VIII which is absent from *Oxythrips.* Macroptera having well developed outer posteroangular setae will key to *Taeniothrips* in couplet 36 in Stannard (1968). However, these setae are shorter and more slender than the inner posteroangular setae and usually are only as long as some posteromarginal setae. Thus, the outer setae of the macroptera are not typical posteroangular setae. The two genera differs as follows: In *Taeniothrips,* two pairs of ocellar setae are on the head, median pair of abdominal tergal setae are short and far apart, and abdominal sternites of males have glandular areas. In *Xerothrips,* three pairs of ocellar setae are on the head, and abdominal tergal median setae are long with those on anterior tergites close to each other.

Xerothrips dissimilis Nakahara, New Species

Female (brachypterous): Body yellowish brown; tarsi yellow, tibiae and femora yellow basally and distally, yellowish brown medially; ocellar crescents gray-brown; setae pale yellow; antennae yellow with apices of III–IV pale brown, distal ⅓ of V brown, VI brown, paler in basal ⅓, VII–VIII brown.

Antenna (Fig. 1): About 2.2 times longer than head; segment III oval, 1.5 (1.5–1.6) times longer than wide; IV oval, 1.35 (1.2–1.3) times longer than wide, apex about ⅔ as wide as segment (Fig. 1b), barely extending distal of base of ventral trichome; VI not pedicelate at base; forked trichome on III on outer apical margin (Fig. 1a), one fork of trichome often oriented dorsad so other fork appears as simple trichome; ventral forked trichome on IV about 10 μm long; inner sense cone of VI in distal ¼ of segment, and 15 μm long (Fig. 1c).

Head (Fig. 2): Wider than long, cheeks slightly arched, shorter than length of eyes, ocellar area slightly raised. Ocellar setae I anterior of fore ocellus (Fig. 2a), about 12 μm long, setae II anterolaterad of fore ocellus (Fig. 2b), near mesal margin of eye, about 7 μm long, ocellar setae III between anterior and posterior ocelli (Fig. 2c), about (15) μ long. Postocular setae between eyes (Fig. 2d): 1 pair behind hind ocelli about 7 μm long, second pair near margin of eyes about 10 μ long, occasionally 1 or 3 pairs present; 2 pairs behind eyes near lateral margin of head. Sculpture of occiput transverse, striae rather far apart. Mouthcone conical, about 1.25 times longer than head, and reaching posterior margin of prosternum.

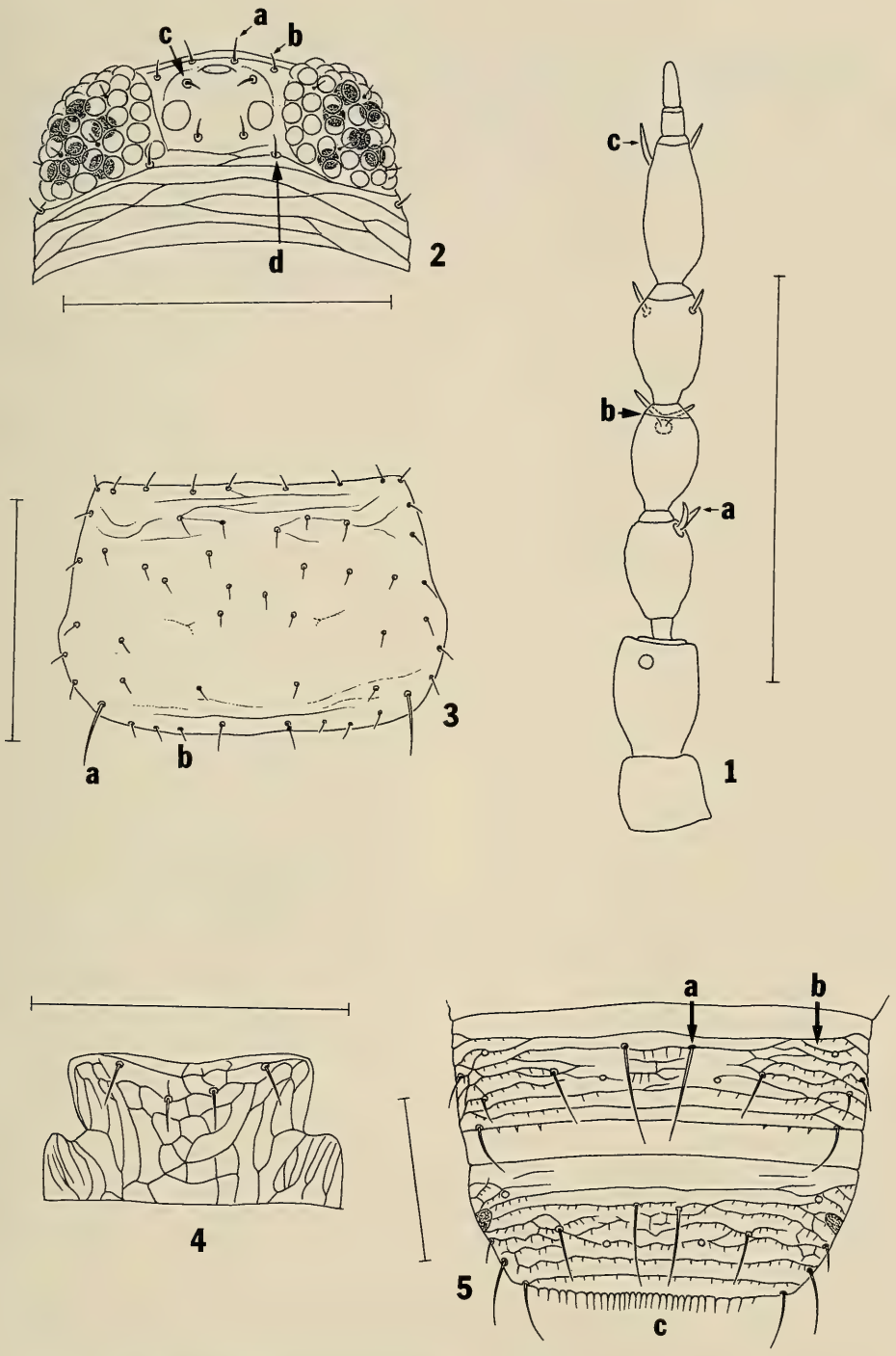
Pronotum (Fig. 3): Wider than long, about 1.5 times longer than head, disc weakly sculptured transversely. Discal setae short; posteroangular setae 27–30 (22–35) μm long (Fig. 3a), $\frac{1}{5}$–$\frac{3}{10}$ as long as pronotum; 4–8 posteromarginal setae (Fig. 3b), median pair longest, 12 (12–15) μm long.

Basantra spinulose; ferna fused; prospinasternum rather wide, with tuberculate posteromedial spina. Mesonotum. Without anteromedial campaniform sensilla. Mesosternal anteromedial process inserts into spina of prospinasternum. Metanotum (Fig. 4). Completely reticulated, without campaniform sensilla. Median setae proximal or posterior of anterior margin, 15 (12–15) μm long; lateral setae 15 (17–20) μm long.

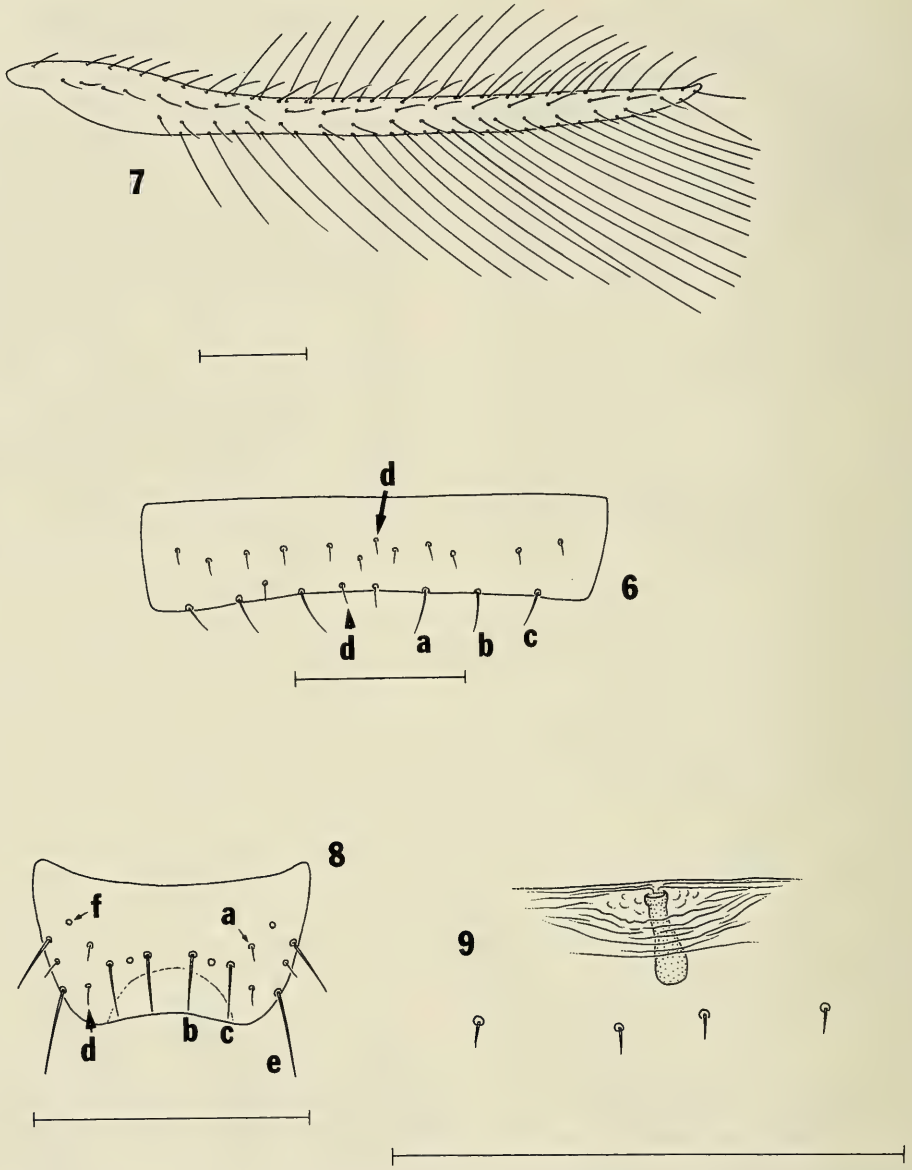
Forewing: Oval, extending posteriorly about length of metanotum, apical margin broadly arched; with few marginal and veinal setae.

Abdomen (Fig. 5): Tergites completely sculptured, rather sparsely striated, with 5–6 striae medially on tergites IV–VII. Median setae on tergite VII 52 (50–62) μm long, on VIII 47 (44–50) μm long (Fig. 5a). Posteromarginal comb complete on tergite VIII (Fig. 5c), close-set, more slender and shorter microtrichia between more developed ones, longest 15 (10–15) μm long. Microtrichia on sculpture lines submarginally (Fig. 5b) and between median setae on tergites VI–VII, throughout tergite VIII, median ones on VI–VIII longest, a few minute teethlike microtrichia submarginally present or absent on tergites VI–VII. Tergite IX with short D1 setae, 2 pairs of campaniform sensilla, posterior pair near B1 setae; B1 setae 52 (42–54) μm long, shorter than tergite X, B2 setae longer than B1 and B3 setae, and 67 (59–74) μm long, B3 setae 57 (50–54) μm long. Tergite X slightly longer than IX, divided in posterior ½ by dorsal split; dorsal campaniform sensilla near base of B1 setae, in posterior $\frac{1}{5}$ of tergite; B1 setae 47 (47–52) μm long, B2 setae 52 (47–52) μm long. Sternite I with 4 minute anteromedian setae. Sternites II–VII with short discal setae (Fig. 6d), 19 (16–19) on VII, and several on posterior margins. B1–B3 setae on sternites III–VII on posterior margin (cf. Fig. 6a–6c). Ovipostior well developed, 227 (203–225) μm long. Pleurotergites III–VII with 2–4 discal setae.

Female (macropterous): Light brown with light orange internal pigments; all tarsi



Figs. 1–5. *Xerothrips dissimilis* brachypterous female. 1, Antenna (a, forked trichome on segment III positioned laterad; b, apex of segment IV; c, sense cone on segment VI). 2, Head (a, ocellar seta I; b, ocellar seta II; c, ocellar seta III; d, postocular seta). 3, Pronotum (a, posteroangular seta; b, posteromarginal setae). 4, Metanotum. 5, Abdominal tergites VII and VIII (a, median seta; b, submarginal microtrichia; c, posteromarginal comb on tergite VIII).



Figs. 6–9. *Xerothrips dissimilis*. 6, Abdominal sternite VI of brachypterous female (a, B1 seta; b, B2 seta; c, B3 seta; d, discal setae). 7, Forewing of macropterous female. 8, Abdominal tergite IX of male (a, D1 seta; b, B1 seta; c, B2 seta; d, B3 seta; e, posterolateral seta; f, campaniform sensillum). 9, Internal gland in abdominal sternite III of male. Scale = 0.1 mm.

yellow, tibiae and femora yellowish brown with apices lighter; forewings light brown; major setae brown; antennae light brown with median part of segment III paler brown.

Similar to brachyptera in most structural characters.

Pronotum: Posteroangular setae 47 μm long, about ⅓ as long as pronotum; occasional specimens with additional (outer) pair of posteroangular setae developed, 30–35 μm long, more slender and shorter than inner pair, about as long as some posteromarginal setae.

Forewing (Fig. 7): Pointed apically, 573–722 μm long, about 47–57 μm wide at midlength; 19–25 costal setae, about 44 μm long at midlength, slightly shorter than width of wing; 9–15 anterior fringe cilia; 16–22 setae in complete row on forevein, 10–16 setae on hindvein. Scale with 5 marginal and 1 discal setae.

Abdomen: Posteromarginal comb on tergite VIII with microtrichia 15–20 μm long, longer than on brachyptera. Ovipositor 178–190 μm long, shorter than on brachyptera.

Male (brachypterous): Similar to but shorter than female brachyptera. Abdominal tergite VIII with posteromarginal comb of microtrichia. Abdominal tergite IX with bristlelike setae (Fig. 8); D1 setae 12 μm long (Fig. 8a), anterolaterad of B1 setae and farther apart than distance between B2 setae; B1–B2 setae in arched line (Fig. 8b, 8c), B1 and B2 setae 17–27 μm long, B3 setae 12 μm long (Fig. 8d), between B2 seta and posterolateral seta (37 μm long) (Fig. 8e); campaniform sensilla between B1 and B2 setae, another pair anterolaterad of D1 setae (Fig. 8f). Sternites II–VIII with discal setae; abdominal segment III with internal gland that opens through a small orifice in slightly differentiated area near anteromedial margin of sternite (Fig. 9).

Measurements of body and antenna of brachypterous female in microns. Measurements of holotype given first followed by those of paratypes in parenthesis. Body length 1136 (1160–1260) (distended). Antenna: total length 191 (183–192); length and width of segment I 17(17), 22(22–24); II 30(27–32), 22(22–23); III 30(30), 20(18–20); IV 27(24–27), 20(20); V 30(27–30), 18(20); VI 38(35–37), 17(17); VII 7(6–7), 7(7); VIII 12(12–15), 5(5–6). Head length 86, width at eyes 111 (101–117), width at cheeks 119 (111–128); eye length 50, width 35 (35–37); mouthcone length 109 (106–109); pronotum length 109 (111–124), width 161 (161–180); length of tergite IX 54 (54–57); length of tergite × 62 (62–64).

Measurements of body and antenna of macropterous females in microns. Body length 996–1050. Antenna: Total length 221–226; length and (width) of segment I 20(22–24), II 32 (24), III 35–37(17–22), IV 30–31(17–20), V 32–35(17), VI 45–47(17), VII 8–10(6–7), VIII 16–17(5).

Measurements of body and antenna of brachypterous male in microns. Body length 950 (distended). Antenna: Total length 157; length and (width) of segment I 15(20), II 27(21), III 25(16), IV 21(17), V 22(18), VI 32(15), VII 5(7), VIII 10(5).

Type material.—Holotype brachypterous ♀ (USNM), 19 brachypterous ♀ paratypes: Mojave, Kern Co., California, *Eriastrum densifolium* subsp. *mohavense* (T. T. Craig) Mason, I-31-68, T. R. Haig (CDA 68B2) (CDFA, USNM). Brachypterous paratypes. California: 4 mi. east of Monolith (Kern Co.), 86 ♀, 3 ♂, *Eriastrum densifolium* subsp. *mohavense,* 17-IX-66, T. R. Haig (CDFA, FSCA, INHS, NHM, SMF, UCD, UCR, USNM). Macropterous ♀ paratypes. California: Davis (Yolo Co.), 1, *Quercus agrifolia* Nee, 22-X-52, E. I. Schlinger (UCD); 1, under grape vine bark, 16-I-39, S. F. Bailey (UCD); Porterville (Tulare Co., 1, in lichen on fig tree, 16-I-36, E. Baker (UCD); Upper Lake (Lake Co.), 1, sweeping grass on ditch bank, 14-V-47, S. F. Bailey (UCD). Nevada: Mercury (Nye Co.), 2, PHA.VAL., 12m(HF)-242, CDJ, 24-V-62 (INHS). Other examined macropterous ♀♀. California: Coarsegold (Madera Co.), 8, *Tillandsia* sp., 9-XII-93, B. Rohn and A. Espinosa (USNM).

Distribution.—United States (CA, NV).

Hosts.—*Eriastrum densifolium* subsp. *mohavense* (T. T. Craig) Mason, grass, *Quercus agrifolia* Nee, *Tillandsia* sp., *Vitis* sp.

Etymology.—Specific epithet based on Latin "dissimilis," meaning unlike. Males of this species have an unusual, internal organ in abdominal segment III with a small orifice on the sternite.

Comments.—Brachyptera are known only from Kern Co., California; whereas the macroptera were collected from different localities in California and Nevada. The

males are brachypterous and known only from the two populations in Kern Co.

Thrips are not normally stained. However, a cleared and stained specimen was selected as the holotype because most of the structural characters of the unstained specimens could not be observed clearly. The coloration is based on the unstained paratypes.

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A NEW GENUS AND A NEW SPECIES OF LEPTOSCELIDINI (HETEROPTERA: COREIDAE) FROM COSTA RICA

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Abstract.—***Sephinioides ugaldei*** **new genus** and **new species** from Costa Rica are described in the tribe Leptoscelidini (Coreidae). Habitus view illustrations and drawings of the male and female genitalia are provided to help distinguish these taxa. Key to the known Leptoscelidini from Costa Rica is provided.

Key Words: Insecta, Heteroptera, Leptoscelidini, Coreidae, new genus, new species, Costa Rica

Members of the tribe Leptoscelidini are found primarily in the tropical and subtropical regions of the Western Hemisphere, reaching their greatest diversity in Colombia and Brasil. The species are usually medium sized, elongate, head porrect and produced forward between bases of antennae; femora usually armed and tibiae simple, cylindrical, lacking foliaceous dilations.

The tribe contains 9 genera and about 43 species: *Amblyomia* Stål (1), *Coribergia* Casini (1), *Dalmatomammurius* Brailovsky (6), *Kalinckascelis* Brailovsky (1), *Leptoscelis* Laporte (18), *Malvana* Stål (4), *Malvanaioides* Brailovsky (2), *Phthia* Stål (8) and *Plunentis* Stål (2) (Bergroth 1913, Blöte 1936, Brailovsky 1989, 1990a, b, 1993, Lethierry and Severin 1894).

This article adds one new genus and one new species collected in Costa Rica. A striking feature of this new genus is its pronotal disc broadly convex, anteriorly cleft (frontal view), with femora unarmed and humeral angles acutely produced into an elongate spine. With the inclusion of this new taxa, the tribe Leptoscelidini is now represented in Costa Rica by two genera and three species.

The following abbreviations are used for the institutions cited in this paper: INBIO (Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Heredia, Costa Rica); UNAM (Instituto de Biología, Universidad Nacional Autónoma de México, México D.F.).

All measurements are given in millimeters.

Sephinioides Brailovsky, New Genus

Diagnosis.—*Phthia* Stål, differs from all other members of the tribe, including *Sephinioides,* in having the abdominal spiracle closer to the posterior margin than to the anterior margin of the supporting segment, in all other it is closer to the anterior border.

Sephinioides Brailovsky, new genus, like *Malvana* Stål has the humeral angle projected on a long and acute spine, the triangular processes of the posterior border of the pronotum long and broad, and the antennal segment IV is the longest. *Malvana* can be distinguished by the pale yellow or orange coloration of the body, the humeral angle conspicuously expanded, the femora armed, the antennal segment I

being the shortest, the pronotal disc flat and declivent, the anterolateral border of the pronotum with fine spination, the hemelytral membrane extending slightly beyond the apex of the last abdominal segment and the connexival segment is not elevated above the dorsal segments of the abdomen. In *Sephinioides* the body is black and orange red, the humeral angles not expanded, the femora unarmed, the antennal segment III being the shortest, the pronotal disc broadly convex and anteriorly cleft, anterolateral border coarsely toothed, hemelytral membrane extending far from the apex of the abdomen and the connexival segments higher than abdominal segments.

In *Leptoscelis* Laporte, the femora are armed, the humeral angles never projected in a long and acute spine, the pronotal disc is flat and declivent and the antennal segment IV shorter than III.

In *Malvanaioides* Brailovsky like in *Sephinioides* the antennal segment IV is the longest and the III is the shortest. However, it is differentiated by having the femora armed, the humeral angles never projected in a long and acute spine, by the rostrum reaching the middle third of the abdominal sternite IV and by the blue green to violet iridescence of the body. In the new genus the rostrum barely reaches the posterior border of the hind coxae and the body lacks iridescence.

Generic description.—*Head:* Wider than long, pentagonal, porrect, and produced forward between bases of antennae; tylus unarmed, convex, extending anteriorly to the jugae and slightly raised in lateral view; jugae unarmed, thickened and shorter than tylus; antenniferous tubercle unarmed; antennal segment I much longer than head, thicker than succeeding segments, slightly curving, and external face longitudinally carinate; segments II and III cylindrical, with the external face longitudinally carinate; segment IV fusiform; segment IV longest, segment III shortest and I longer than II; preocellar pit obliquely deep; ocelli moderately elevated; eyes hemispherical and prominent; postocular tubercle absent to scarcely indicated; buccula short, not extending beyond antenniferous tubercle, with sharp spine anterior projection; rostrum reaching posterior border of hind coxae; rostral segment IV longest, segment III shortest and I longer than II; neck short.

Thorax.—Pronotum wider than long, trapeziform, markedly declivent; disc broadly convex, anteriorly cleft (in frontal view), forming two humps, lateral to the midline; frontal angle conical, crested with spines; collar wide; anterolateral border coarsely toothed, with short and large teeths; humeral angles acutely produced laterad into an elongate spine; posterolateral borders convex and strongly dentate at is upper half, inferior half smooth and slightly concave; triangular processes evident; posterior border straight; callus raised and smooth, except the middle third which is crested. Prosternum with deep excavation; mesosternum with a broad, shallow, medio-longitudinal groove; anterior lobe of metathoracic peritreme elevated and reniform, posterior lobe small.

Legs.—Unarmed; tibiae cylindrical, sulcate; hind tibiae longer than hind femora.

Scutellum.—Triangular, flat, wider than long; apex subacute and slightly convex.

Hemelytra.—Macropterous, extending far from the apex of the last abdominal segment; costal margin emarginate and apical margin weakly concave.

Abdomen.—Connexival segments higher than margin of hemelytron at rest; posterior angle of each connexival segment extended into a short and acute or blunt spine; abdominal spiracle closer to anterior border.

Integument.—Body surface shining and mostly glabrous; pronotum, collar and scutellum strongly punctate and striate; head, clavus, corium and thorax minutely punctate; abdominal sterna and exposed parts of genital segments of both sexes smooth. Antennal segments and legs with long to short decumbent to suberect setae.

Male genitalia.—*Genital capsule:* Posterior margin shallowly concave between short, blunt lateral lobes, intermediate margin shallowly bisinuate at each side of median angular emargination (Fig. 4). Parameres. Shaft robust, with sides almost parallel; apical lobe slightly curved, distally narrowly rounded (Figs. 2, 3).

Female genitalia.—Abdominal sternite VII with plica and fissura; plica noticeably elevated, rectangular, transversely straight and leaving the middle apical third of fissura; gonocoxae I enlarged dorso-ventrally, in caudal view closed, in lateral view straight, with superior half broad and rounded; paratergite VIII triangular, with visible spiracle; paratergite IX squarish, larger than paratergite VIII. Spermatheca. Bulb spherical, duct moderately coiled, flank distinct and chamber elongate (Fig. 5).

Etymology.—Named for its similarity of appearance to *Sephina*; feminine.

Type species.—*Sephinioides ugaldei* Brailovsky, new species.

Sephinioides ugaldei Brailovsky, New Species
(Figs. 1–5)

Description.—Measurements: *Male:* Head length 2,20; interocular space: 1.46; interocellar space 0.67; preocular distance 1.36; width across eyes 2.81; length antennal segments: I, 4.24; II, 3.34; III, 2.35; IV, 7.50. Pronotum: Total length 5.24; width across frontal angles 2.35; width across humeral angles 8.87. Scutellar length 2.41; width 2.73. Hemelytral membrane: Total length 16.50. Abdomen: Maximum width 10.20. Total body length 23.75.

Female: Head length 2.25; interocular space 1.50; interocellar space 0.70; preocular distance 1.46; width across eyes 2.94; length antennal segments: I, 4,54; II, 3.71; III, 2.72; IV, 7.68. Pronotum: Total length 5.54; width across frontal angles 2.41; width across humeral angles 9.80. Scutellar length 2.65; width 2.86. Hemelytral membrane: Total length 17.00. Abdomen: Maximum width 10.80. Total body length 26.15.

Male: Dorsal coloration: Including the antennal segments I to IV shining black; hemelytral membrane dark with metallic blue-green iridescens; connexival segments bright orange red, with posterior third of segments II to VI black; dorsal abdominal segments bright orange red. Ventral coloration: Bright orange red, with following areas black: head, rostral segments I to IV, prosternum, mesosternum and metasternum, legs, anterior and posterior lobe of metathoracic peritreme, a huge discoidal spot on pro-meso and thoracic metapleura, anterior third of the upper margin of metathorax, posterior third of pleural sterna II to VI, a huge discoidal spot running lateral to the midline of the abdominal sterna III to VII and a irregular spots on the midline of the abdominal sterna IV to VII.

Female: Coloration: Similar to male. Connexival segments VIII and IX and genital plates bright orange red; dorsal abdominal segments VIII and IX bright orange red, with black irregular spots on the middle third.

Variation.—1—Coxae black with orange hazel reflections. 2—Middle third of the abdominal sterna IV and V entirely bright orange red. 3—Middle third of the abdominal sternite VII with black discoidal spot.

Types.—Holotype: ♂, Costa Rica, Guanacaste Prov., Estación Cacao, SW side of Volcan Cacao (1000–1400 mts.), September 1989, R. Blanco and C. Chavez (INBIO). Paratypes: 6 ♂, 5 ♀, Costa Rica, Guanacaste Prov., Estación Cacao, SW side of Volcan Cacao (1000–1400 mts.), April 1988, July to December 1989, M. Espinoza, R. Blanco and C. Chavez (UNAM, INBIO); 1 ♀, Costa Rica, Guanacaste Prov., Cerro El Hacha, 12 km., SE La Cruz (300 mts.), May 1988, M. Espinoza (INBIO).

Etymology.—Named for Jesus Armando Ugalde Gomez (INBIO).

Distribution.—Known only from the type locality, Costa Rica.

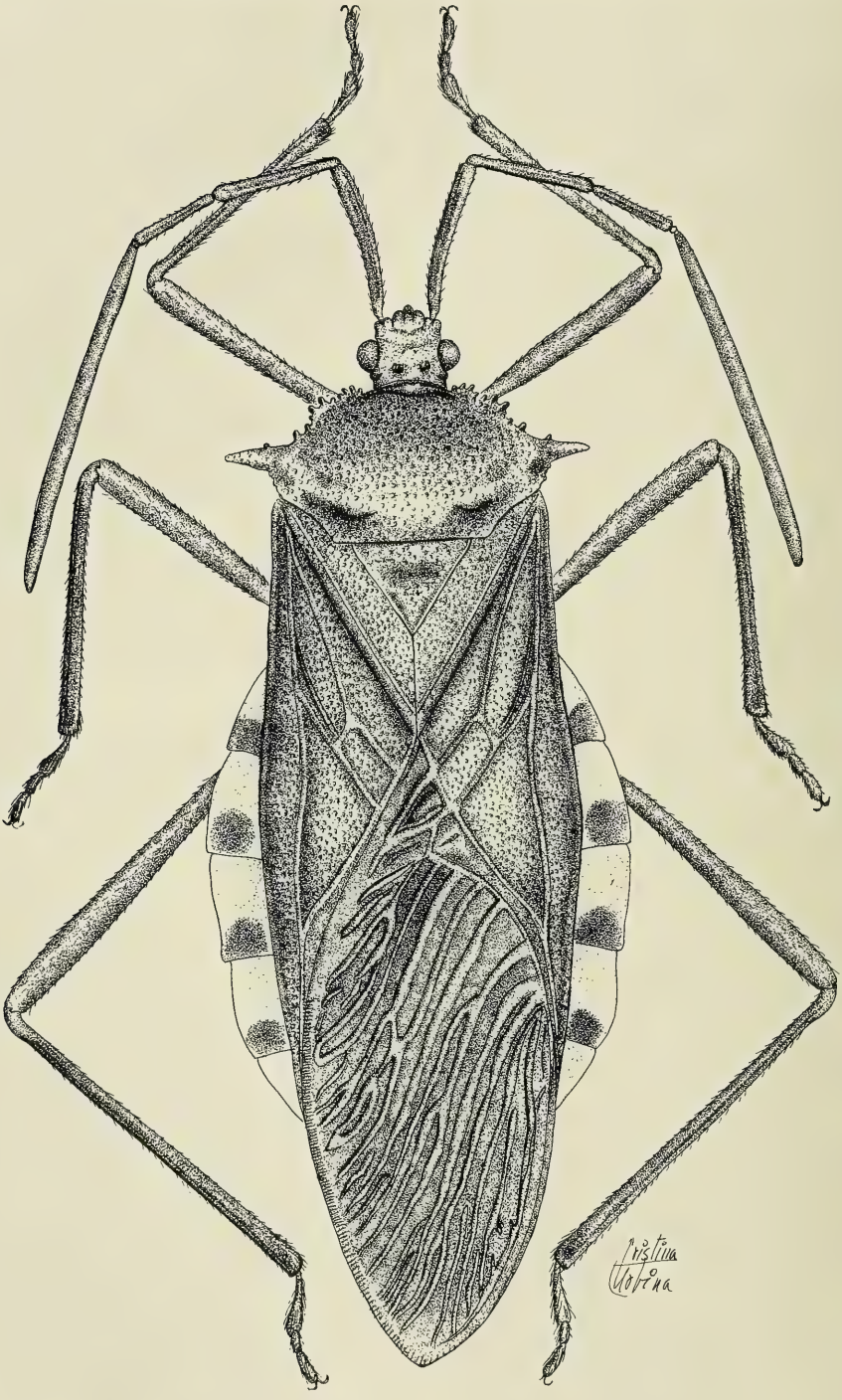
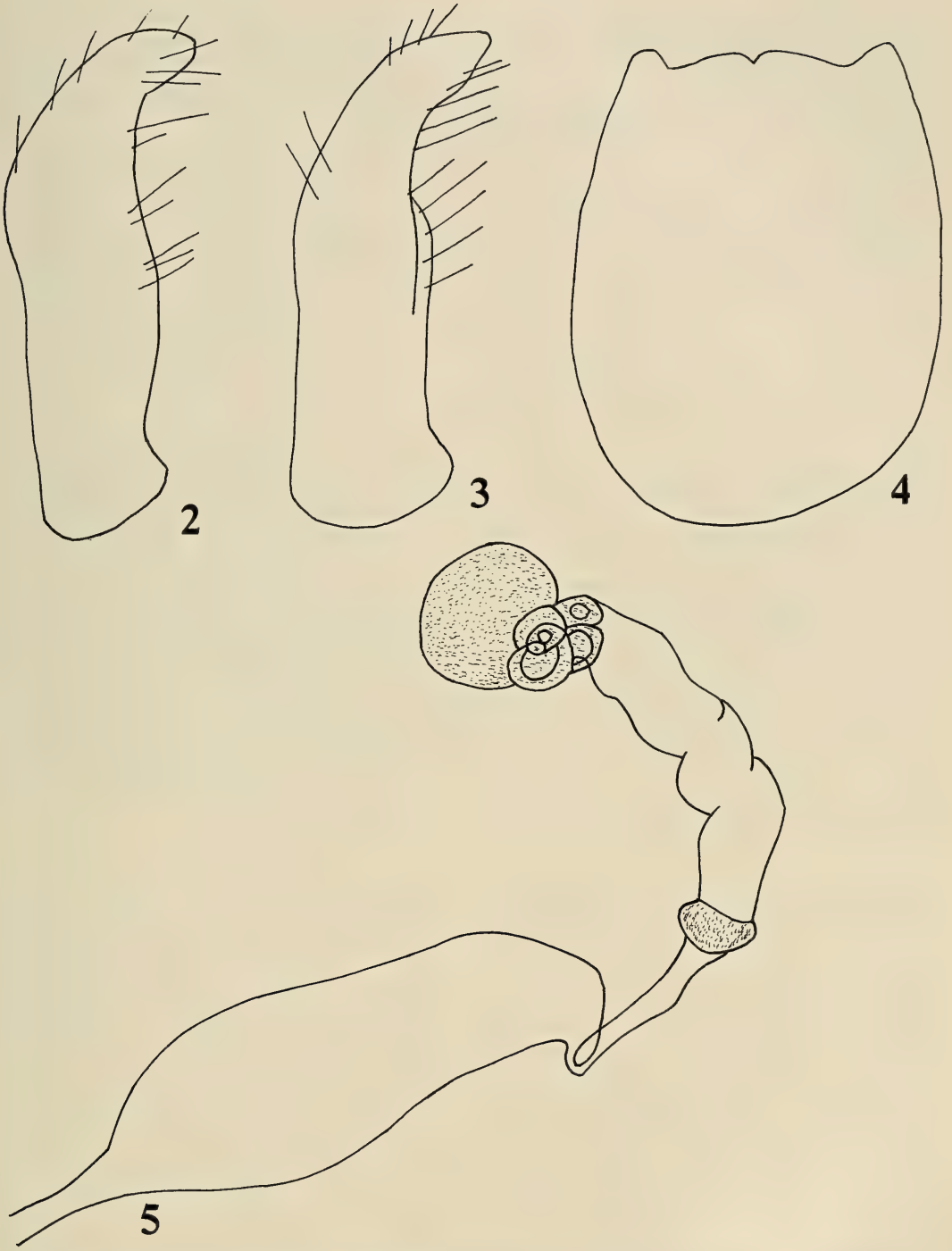


Fig. 1. Dorsal view of *Sephinioides ugaldei*.



Figs. 2–5. *Sephinioides ugaldei.* 2, 3, Parameres. 4, Male genital capsule in caudal view. 5, Spermatheca.

Key to the Known Leptoscelidini from Costa Rica

1. Abdominal spiracle closer to the anterior border than to the posterior; femora unarmed; pronotal disc broadly convex and anteriorly cleft . . . . . *Sephinioides ugaldei* Brailovsky
– Abdominal spiracle closer to the posterior border than to the anterior; femora armed; pronotal disc flat, declivent 2
2. Body with blue-green iridescence; acetabulae with creamy yellow spot; anterolateral border of the pronotum without spines . . . . . *Phthia lunata* (Fabricius)
– Body without metallic iridescence; acetabulae black to red-brown; anterolateral border of the pronotum with spines . . . . . *Phthia picta* (Drury)

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MELIGETHES VIRIDESCENS (F.) (COLEOPTERA: NITIDULIDAE) IN MAINE, NOVA SCOTIA, AND PRINCE EDWARD ISLAND: DIAGNOSIS, DISTRIBUTION, AND BIONOMICS OF A PALEARCTIC SPECIES NEW TO NORTH AMERICA

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Abstract.—One of the common "blossom" or "pollen" beetles (Nitidulidae) of the Palearctic region, *Meligethes viridescens* (F.), is reported for the first time from North America. Adults were collected in June 1993 and 1995 in Maine (USA) and in July 1994 and 1995 at several localities in Nova Scotia and Prince Edward Island (Canada). This immigrant species, a known pest of brassica-type cruciferous crops (oilseed rape), is diagnosed and redescribed. A habitus photograph of the adult and other principal morphological characters that facilitate its identification are provided. Its known distribution and habitat in North America, interception records at North American ports, host plants, seasonal history, and economic importance are summarized. An existing key to the North American species of *Meligethes* is modified to include *M. viridescens.* The historic and current status of the similar *M. aeneus* in North America is also discussed.

Key Words: Coleoptera, Nitidulidae, *Meligethes viridescens,* pollen or blossom beetles, North America, distribution, bionomics

The Canadian Maritime Provinces and Newfoundland have yielded more records of adventive species of insects than any other region of North America. The port city of Halifax, Nova Scotia, is especially noteworthy for its rich immigrant fauna (Brown 1940, 1950, 1967, Lindroth 1957, Turnbull 1979, Hamilton 1983, Morris 1983, Wheeler and Henry 1992). Recently reported Palearctic insects occurring in the Canadian Maritimes include the nabid bug *Himacerus apterus* (F.) in eastern Nova Scotia (Larivière 1992), the weevil *Apion hookeri* Kirby in northern Nova Scotia (Peschken et al. 1993), the micropezid fly *Micropeza corrigiolata* (L.) in New Brunswick (Hoebeke and Wheeler 1994), and the pteromalid *Pteromalus elevatus* (Walker), a parasitoid of a knapweed gall fly, in Nova Scotia, New Brunswick, and Newfoundland (Hoebeke and Wheeler 1996).

We report herein the first known occurrence in North America of the Palearctic nitidulid *Meligethes viridescens* (F.). We observed numerous beetles attracted to the inflorescences of wild radish or charlock [*Raphanus raphanistrum* (*L.*)] growing along the upper shoreline at various coastal localities in Nova Scotia and Prince Edward Island in July 1994 and 1995; additional specimens were collected along the shoreline at Lincolnville (Waldo Co.), Maine, in late June 1993 and early June 1995.

Diagnosis and Description

From all other metallic green or bluish species of the genus *Meligethes* occurring

in North America [*M. aeneus* (F.) and *M. simplipes* Easton], *M. viridescens* can be readily distinguished by the presence of a subapical tooth along the posterior margin of the middle femur (Fig. 1); the other species lack this subapical tooth.

Meligethes viridescens agrees with characteristics of the genus as described by Parsons (1943), Easton (1955), and Audisio (1993), and can be additionally characterized by the following description taken (in part) from Audisio's monograph:

Body elongate-oval, moderately convex (Fig. 2), shining, color extremely variable, the great majority of specimens dark green with strong metallic luster, frequently blue, sometimes violet, rarely blackish, bronze, copperish or goldish. Legs and mouthparts yellowish or orange-yellow, proximal antennal segments uniformly yellowish. Pubescence fine, short and sparse, silver or yellow, somewhat uniformly distributed. Punctation of the dorsal portion of the body somewhat coarse and conspicuous, with the diameter of punctures about equal to 2× that of an ommatidium (of the compound eye), and each puncture separated 0.5–1.5× their own diameter; punctation of head in general finer and denser, while more coarse and scattered on elytra. Dorsal surface between punctures often with microreticulations, generally dull in appearance; surface sometimes smooth and glossy, microsculpture variable among populations. Length 2.0–2.9 mm.

Pronotum transverse, somewhat feebly arcuate laterally, with maximum width at the middle. Scutellum somewhat conspicuous, semicircular. Elytra elongate, in general subparallel or feebly oval, distinctly wider than pronotum at base, humeri distinctly angulated. Mesosternum with longitudinal median carina, not attaining posterior margin. Metasternum of male with weak triangular impression along posterior margin, less distinct in female.

Middle and posterior femora relatively large and robust; anterior femur more narrow and feebly undulate along anterior margin, without evident tooth near insertion with trochanter; middle femur very characteristic, a strong dentiform tooth along posterior margin near apex (Fig. 1); anterior tibia moderately long and narrow, finely denticulate along external margin.

Male and female genitalia are described and illustrated fully by Audisio (1980, 1993).

In habitus (Fig. 2) and other principal morphological features, *M. viridescens* is most similar, and probably closely related, to *M. czwalinai* Reitter, a montane species occurring in south-central Europe. Detailed descriptions and illustrations of the immature stages of *M. aeneus* and *M. viridescens* and a diagnosis for distinguishing the larvae of both species are provided by Fritzsche (1955) and Osborne (1965).

Easton's (1955) key is modified below to provide the primary characters to distinguish *M. viridescens* from other species of *Meligethes* occurring in North America.

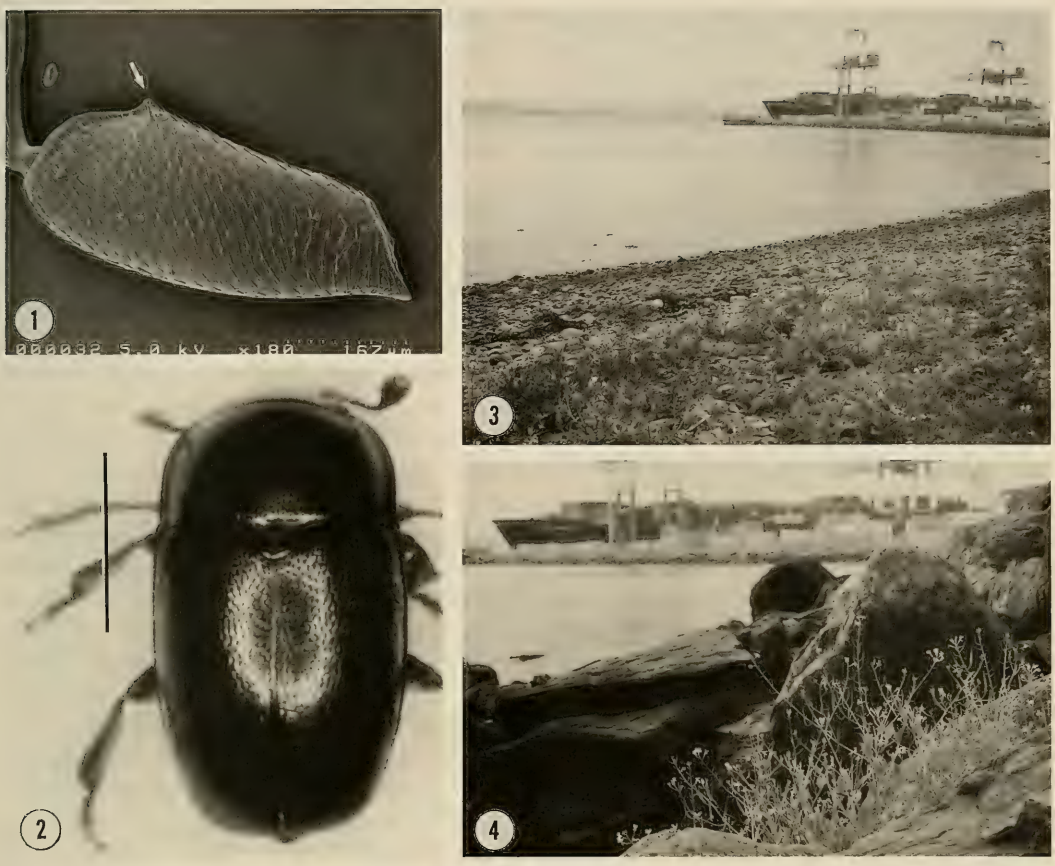
(Couplets 1–2 unmodified).

3. Middle femur with subapical tooth along posterior margin (Fig. 1) . . . . . *viridescens* (F.)
– Middle femur without subapical tooth 3a
3a. Form slightly to moderately convex; punctures of elytra more dense, as large as eye facets, separated by 1 to 1½ their diameters . . . . . *aeneus* (F.) [*sensu* Audisio (1993) including the junior synonyms *dauricus* Motschulsky, *rufimanus* Leconte, and *cleominis* Easton]
– Form distinctly more convex; punctures of elytra less dense, slightly larger than eye facets, separated by 2½ their diameters . . . . . *simplipes* Easton

(Couplets 4–6 unmodified).

Distribution of *Meligethes viridescens* and North American Interception Records

In the Palearctic region, *M. viridescens* exhibits a primarily Euro-mediterranean distribution pattern (see map in Audisio 1993:555). It is widespread throughout most of Europe, ranging north to Sweden, northcentral Norway, and southern Finland,



Figs. 1–4. 1, Middle femur of *Meligethes viridescens*; note dentiform tooth along outer posterior margin (arrow). 2, Dorsal habitus of *Meligethes viridescens*. Scale line = 1.0 mm. 3–4, Host plant habitat: wild radish (*Raphanus raphanistrum*) growing along upper shoreline of Halifax harbor, adjacent to the cargo container terminal.

east to Kazakistan of the former Soviet Union, southeast to the Caucasus, northern Iran and Syria, and southwest to Morocco, Algeria, and northcentral Tunisia.

In North America, *M. viridescens* is known from several coastal localities in Nova Scotia and Prince Edward Island, and Lincolnville, Maine. Complete locality data for all specimens collected to date are as follows (all collections were made from flowers of wild radish (*Raphanus raphanistrum*), unless stated otherwise):

UNITED STATES: Maine: *Waldo Co.* Lincolnville, 24-VI-1993, 2-VI-1995 (ex *Lathyrus maritimus*).

CANADA: Nova Scotia: *Colchester Co.,* Truro, 22-VII-1995; Bible Hill, Nova Scotia Agricultural College, 22-VII-1995. *Halifax Co.,* Halifax, Pt. Pleasant Park nr. container terminal, 18-VII-1994, 20/21-VII-1995. *Lunenberg Co.,* Lunenberg, 21-VII-1995. *Pictou Co.,* Pictou, 22-VII-1995. Prince Edward Island: *Kings Co.,* Georgetown, 25-VII-1995. *Prince Co.,* Summerside, 26-VII-1995. *Queens Co.,* Charlottetown, 26-VII-1995; S. of Cymbria, 26-VII-1995; North Rustico, 26-VII-1995.

Initially, we collected specimens on 18 July 1994 from flowers of wild radish growing abundantly along the upper shoreline of Halifax Harbour adjacent to Point Pleasant Park and the harbor container terminal (Figs. 3–4). By 15 August 1994, beetles had apparently dispersed, as no speci-

mens could be found on flowers of wild radish at this site (A. A. Wilson, pers. comm.). In late July 1995, we again collected numerous specimens from wild radish flowers at several coastal sites in Nova Scotia and Prince Edward Island. A single specimen was collected by the authors by sweeping flowers of a shoreline crucifer (subsequently identified as *Raphanus raphanistrum*) at Lincolnville, Maine, on 24 June 1993. Five specimens were collected at this site on 2 June 1995 from flowers of beach pea, *Lathyrus maritimus* (L.) Bigelow (Fabaceae); the wild radish, although present, was not in bloom.

Voucher specimens from Nova Scotia and Prince Edward Island are deposited in the collections of Cornell University (Ithaca, NY), the United States National Museum of Natural History (Washington, DC), the Nova Scotia Museum (Halifax), and the Canadian National Collection of Insects (Ottawa); the Maine specimens are deposited at Cornell.

Confirmed specimens of *M. viridescens* have seldom been intercepted at U.S. ports of entry. In fact, only 1 interception report (for the period July 1, 1971–June 30, 1972) is documented in the "List of Intercepted Plant Pests" compiled by the U.S. Department of Agriculture: in Michigan on heather [*Calluna vulgaris* (L.)] originating from the United Kingdom. Through the courtesy of J. Pakaluk (Systematic Entomology Laboratory, USDA-ARS, Washington, D.C.), we became aware of 2 specimens of *M. viridescens* (or near *viridescens*) housed in the collection of the U.S. National Museum of Natural History with interesting label data. One specimen bears the labels: "Canada, Intrc. Boston, Mass., 20 July 1959"/"G. Crampton, ex *Syringa* sp., 59-14448"/"*viridescens* (F.) det. Connell, Easton AMNH 14:64," and the other specimen with the labels: "Poland, Intrc. New York, N.Y., 25 July 1963"/"L. N. Sedgewick, ex flower - Rose, 63-362"/"*Meligethes* nr. *viridescens* (F.) det. Connell 63." These two specimens obviously represent cases of interception during USDA cargo inspections at ports of entry (Boston and New York).

Status of *Meligethes aeneus* in North America

Checklists, catalogues, and faunal lists of the Coleoptera, as well as notes in the literature, have included *M. aeneus* (sometimes under one of its various synonyms) as a member of the western North American fauna for well over a century (see explanation given by Easton [1955: 92–97] for *M. rufimanus* LeConte and references cited therein; also Leng 1920, Chittenden 1925, Parsons 1943, Horion 1960). *Meligethes aeneus* is extremely common and widespread throughout most of Eurasia; it has also been reported in the extreme northwest portion of Mexico (Audisio 1993), and recent citations also place it in the Canary Islands (Tenerife) (Israelson et al. 1982) and the Azores (San Miguel and Flores) (Israelson 1984).

During 1967–1977, specimens of *M. aeneus* were intercepted on numerous occasions at major U.S. ports of entry. At least 11 interception records are documented in the "List of Intercepted Plant Pests" compiled by the U.S. Department of Agriculture. Most specimens found during inspection were associated with various mixed (indeterminate) flowers, cut flowers including *Gladiolus* sp., cauliflower and cabbage (*Brassica oleracea* vars.), lupine (*Lupinus* sp.), and apple (*Malus sylvestris*), originating from such European countries as England, Germany, Denmark, Norway, France, Netherlands, and Poland.

As a result of A. M. Easton's (1947, 1955, 1959) revisionary studies of the North American element of the genus *Meligethes,* eight species in the Nearctic fauna were recognized, including *atratus* Olivier, *nigrescens* Stephens, *dauricus* Motschulsky, *pinguis* Horn, *canadensis* Easton, *cleominis* Easton, *simplipes* Easton, and *saevus* LeConte. Easton concluded that all previous North American records of the Palearctic *M. aeneus* actually referred to other

species, not the "true" *aeneus* (sensu Fabricius). On careful examination most Nearctic specimens among material studied by Easton and previously determined as *M. aeneus* proved to be representatives of either *M. simplipes* Easton if collected in the East (Ontario and eastern United States to Ohio and Tennessee), or *M. dauricus* Motschulsky (=*rufimanus* LeConte) if collected in the West (a Holarctic species, in western Canada, western United States, adjacent Mexico, and east to Kansas and Nebraska). Specimens that formed the basis for an eastern North American record (Pennsylvania) of *M. aeneus* (Peng-Fi and Larson 1949) proved to be the Holarctic species *M. nigrescens* (see Easton 1955:93). Blatchley's (1910) record of "*M. aeneus*" in his Coleoptera of Indiana actually refers to *M. simplipes* (Easton 1955:97). Not having examined a "true" specimen of *M. aeneus* among the material he studied, Easton (1955) thus removed this common and widespread Palearctic species from the North American faunal list.

Audisio (1993:526, 528), in his monograph of the Nitidulidae of Italy, reestablished the presence of *M. aeneus* in western North America, by synonymizing *M. dauricus, M. rufimanus,* and *M. cleominis* under *M. aeneus.*

Bionomics and Economic Importance of *Meligethes* spp.

Both *M. viridescens* and *M. aeneus* have been discussed extensively as pests of cruciferous crops. The following bionomic information has been gleaned mainly from Fritzsche (1957), Horion (1960), Fougeroux (1987), Halstead (1988), Lamb (1989), and Audisio (1993). Their biology and seasonal history are very similar.

Meligethes viridescens and *M. aeneus* breed in the flower buds of brassica seed crops (Brassicaceae) and other related plants. Host injury is greatest at the early bud stage. The extent of injury depends on the weather, the time and severity of feeding, and the nutritional and developmental state of the cruciferous plants. In general, larvae cause no significant economic damage. *Meligethes viridescens,* particularly its larval stages, is closely associated with many cruciferous genera, but mostly species of *Brassica, Cardamine, Arabis,* and *Erucastrum* (Audisio 1993). Adults also feed on pollen from a wide array of flowers, including the Asteraceae, Ranunculaceae, and Rosaceae. Because of their pollen-feeding habits as adults and larvae, they are commonly referred to as "pollen" or "blossom" beetles in the European literature. In Europe, the increasing acreage of oilseed rape is thought to have triggered problems from *Meligethes* beetles in gardens and cash crops (Finch et al. 1990, Winfield 1992). *Meligethes viridescens,* considered one of the more adaptable species of the genus, is encountered frequently and abundantly where crucifers grow or are cultivated, from sea level to 800–1000 m elevation. It is less common at mountain sites.

Meligethes adults may be effective pollinators of their brassica-type hosts based on field and experimental evidence (Faber et al. 1920, Halstead 1988), and are regularly observed to chew stigmas and anthers of their hosts (Scherney 1953). Crowson (1988) suggested that dorsal setiferous pits on the adult mandibles (of *Meligethes* spp.) actually serve to transport pollen grains that effect pollination.

Overwintering *Meligethes* beetles generally leave the soil when the ambient temperature reaches about 8–10° C (46–50° F, usually the end of March or early April) and seek out flowering plants near their overwintering quarters. Beetles overwinter in moderately damp, well-ventilated soil that has unmatted plant cover; these overwintering sites are generally found in wooded areas, or in the transitional vegetative zones bordering these areas. Emergence from overwintering sites depends on temperature, and on moisture and CO_2 content of the soil; *M. aeneus* is generally the first to appear in the spring, followed by *M. viridescens.* Females leaving the soil have

undeveloped ovaries, and to reach sexual maturity they begin to feed on pollen of various flowering herbaceous weeds and shrubs. As soon as the air temperature approaches ca. 15° C (59° F), the beetles fly in search of cruciferous plants (including cultivated brassica crops such as oilseed rape). While the weather is cool, the beetles can cause considerable feeding damage to the flower buds and developing flowers of crucifers. When the weather becomes warmer, the beetles feed mostly on pollen and nectar and cause little damage to the plant and reproductive structures. Eggs are laid in the flower buds, with preference for buds 2–3 mm long. Fecundity depends on temperature and relative humidity; 78–210 eggs are generally laid by each female, with 1–2 eggs per flower bud. A large number of eggs in a single bud indicates multiple ovipositions. The female chews through the involucre or bracts of the flower bud and lays an egg on the stamen, seldom on the pistil or petals. Eggs generally hatch in 4–9 days. The newly hatched larva feeds only on pollen, thus causing little damage to the plant. There are 3 larval instars and complete larval development requires about 4–6 weeks. Pupation takes place in the soil in an earthen chamber about 0.5–2 cm deep. The pupal stage lasts about 15 days. First generation beetles emerge from the beginning of June to mid-July. By the end of summer, beetles begin to seek out overwintering sites. Generally only a single generation is produced annually. Optimal egg development, oviposition, and larval development occur when a temperature of 20–27° C and a relative humidity of >95% are obtained.

Acknowledgments

We especially thank James Pakaluk (Systematic Entomology Laboratory, USDA, ARS, Washington, D.C.) for confirming the identification of *Meligethes viridescens,* for providing us with relevant literature, and for sharing with us valuable label data from specimens of *M. viridescens* in the National Museum of Natural History collection resulting from cargo inspections at major U.S. ports of entry. We are also grateful to Alex A. Wilson (Natural History Section, Nova Scotia Museum, Halifax) for checking the Halifax site (adjacent to Point Pleasant Park) and providing us with an identification of the cruciferous host plant, to W. L. Mountain (Pennsylvania Department of Agriculture, Harrisburg) for identification of the Maine cruciferous host plant, and to Francesco Ferrini (Department of Horticulture, Florence University, Florence, Italy) for translating some Italian literature on *Meligethes.*

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A NEW SPECIES OF *DASINEURA* (DIPTERA: CECIDOMYIIDAE) INFESTING PINXTERBLOOM AZALEA FLOWERS IN MARYLAND AND WASHINGTON, D.C.

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Abstract.—A gall midge (Diptera: Cecidomyiidae) new to science, described and named here as ***Dasineura praecox,*** destroys the flower buds of pinxterbloom, *Rhododendron periclymenoides* (Ericaceae). Its biology is unique for *Dasineura* because adults emerge and oviposit in autumn instead of in spring. Larvae pass the winter as pharate larvae and begin to feed in late winter before the ground is unfrozen.

Key Words: gall midge, *Dasineura,* pinxterbloom, *Rhododendron*

Pinxterbloom azalea, *Rhododendron periclymenoides* (Michaux) Shinners, blooms in late April in the vicinity of Washington, D.C. Among the showy pink flowers can also be seen flower buds that have been aborted. Lying among the scales and flower parts of the aborted buds are yellow gall midge larvae less than 3 mm long. By the end of April, these larvae have dropped to the ground and burrowed into the soil. Affected buds then succumb to rot and die. Earlier notice of this damage to pinxterbloom was given in Gagné (1993, 1994b). A notice on the biology of this new species with color photographs of its damage and life stages is given elsewhere (Gagné 1995). The gall midge responsible is described here for the first time and named *Dasineura praecox.*

Most gall midges and all other *Dasineura* species in northeastern North America whose biologies are known overwinter as full-grown larvae, either in the ground or in plant tissue. They pupate in spring and adults emerge a short time later to lay eggs on or near the newly developed plant tissue. Larvae quickly hatch and, sometimes following a short period of relocation, soon begin feeding. The biology of this new species of *Dasineura* is unique in that adults emerge and lay their eggs in the fall. Eggs develop rapidly as in other species, but the fully developed larvae inside do not hatch until late winter.

Two other gall midges are known to attack the genus *Rhododendron* in eastern US and should not be confused with the new species. These are *Clinodiplosis rhododendri* Felt, which rolls and distorts young leaves of *Rhododendron catawbiense* Michaux and *R. maximum* L. (Specker and Johnson 1988), and the less well known *Asphondylia azaleae* Felt which infests leaf buds of *R. periclymenoides* and *R. prinophyllum* (Small) Millais (Gagné 1989).

Methods.—I observed the progress of the new species found in woods on the South Farm of the Beltsville Agricultural Research Center, Beltsville, MD, from spring 1993 to autumn 1994. Full-grown larvae intended for rearing were placed in a pot filled with damp peat moss. The pot was

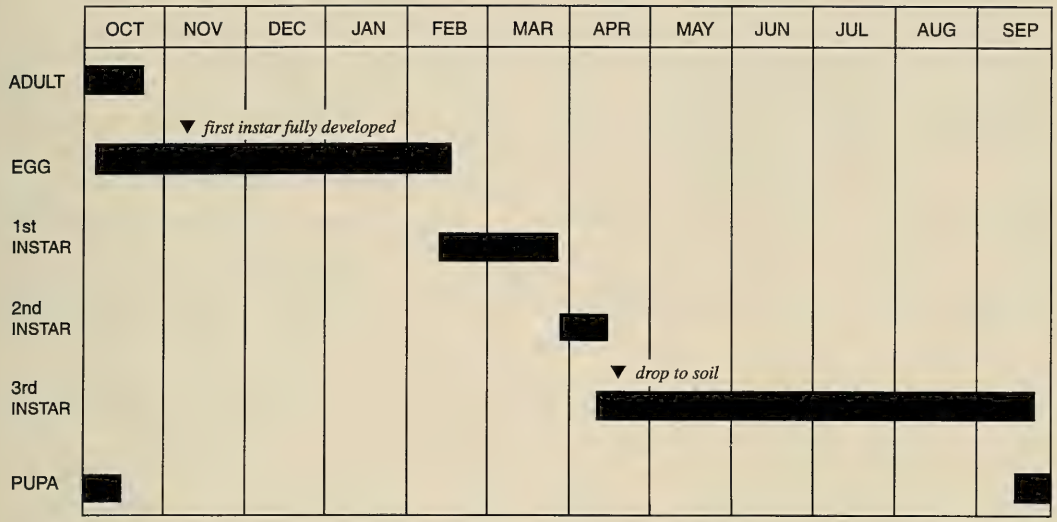


Fig. 1. Development of *Dasineura praecox* over period of one year. End points of bars are approximate, but for the pupa they are estimated only.

kept inside a covered cardboard shoebox with a clear glass vial affixed to one end to attract emerging adults to the light. The vial was checked periodically, and the peat moss kept damp. Some larvae and adults were killed and stored in 70% ethyl alcohol. Specimens for microscopic study were mounted on glass slides in Canada balsam, using the method outlined in Gagné (1989, 1994a). All the study specimens are deposited in the U.S. National Museum of Natural History (USNM). In the description that follows, anatomical terminology of the adult stage follows McAlpine et al. (1981) and that of the larval stage follows Gagné (1989).

Biology.—Fig. 1 summarizes the life cycle of *D. praecox.* In mid-April, 1993, up to 75 mature, yellow, third instar larvae were found among the flower parts and bud scales of unopened flower clusters. Larvae were quiescent and apparently no longer feeding, their heads directed towards the bud apex and not engaged with the plant. For two weeks in April, 1994, larvae lay in the flower buds, although when disturbed they became active and quickly wriggled out of the buds. On the day following a heavy rain on April 28, 1994, no larvae remained in the buds. Upon dropping to the ground, larvae immediately burrowed beneath the surface. There the larvae spun ovoid, white cocoons in which they curled in a "u" shape and became still. I did not determine when the larvae entered the pupal stage, but larvae had not yet pupated by July 30, 1994. Adults emerged between October 1 and October 22. The surface of the peat moss from which they emerged was covered with white pupal exuviae, so the fully developed pupae had crawled from the cocoons to the surface of the peat before adults emerged.

Eggs were found between outer bud scales of flower buds collected in the field on November 8, 1993. Eggs were elongate-ovoid, set side by side in groups of 10 or more. No eggs were found among the primordial flowers, possibly because the tightly overlapping inner bud scales prevented entry of the ovipositor. Eggs collected November 8 contained quiescent, fully developed first instar larvae. All heads were pointed toward the bud apex. Upon hatching in spring the larvae were in position to crawl directly upward, around the top of the outer bud scales, and then downward into the flowers.

Stationary, whitish first instars about 0.4 mm long, were first noticed on February 23, 1994, lying on the surface of stamens and

pistils. Until March 15 when the flower parts of normal and infested flowers were only beginning to swell, larvae grew only to 0.5 mm long. By March 17, 1994, the first instars were noticeably larger, up to 0.6 mm long, and appeared to be more motile. Minute brown areas were noticeable on the pistils or stamens near apparent feeding points. By March 25, 1994, larvae still had not molted but the brown spots were more pronounced and the flower parts showed some distortion. By April 4, all larvae had molted to the second instar. They were greenish white and about 1.6 mm long. Stamens and pistils in infested buds showed some deformation and more extensive brown scarring. Both infested and uninfested buds were enlarging, but none were yet open.

On April 8, second instars were noticeably larger, about 2.3 mm long. Flowers parts showed conspicuous distortion and scattered brown spots. By Apr. 12 the second instars were about 2.5 mm long. At this time stamens and pistils of uninfested buds were elongating and the petals becoming reddish, and new leaves were emerging in straight, narrow fascicles about ½ inch long.

By April 14 most larvae had molted to the third instar. These were yellow and about 2.5 mm long. Third instars apparently did not feed, but crawled away from the stamens and pistils, repositioned themselves head outwards among bud scales, and became inactive. On April 20, 1994, uninfested flowers lengthened and unfurled quickly while infested buds remained closed. On April 25, 1994, uninfested pinxterbloom flowers were in full bloom. Larvae still remained in the flowers until three days later when, evidently in response to a heavy rain, the larvae left the buds and dropped to the ground.

Dasineura praecox Gagné, New Species
(Figs. 1–10)

Adult.—*Wing length:* male, 1.8–2.0 mm (n = 8); female 2.0–2.2 mm (n = 8).

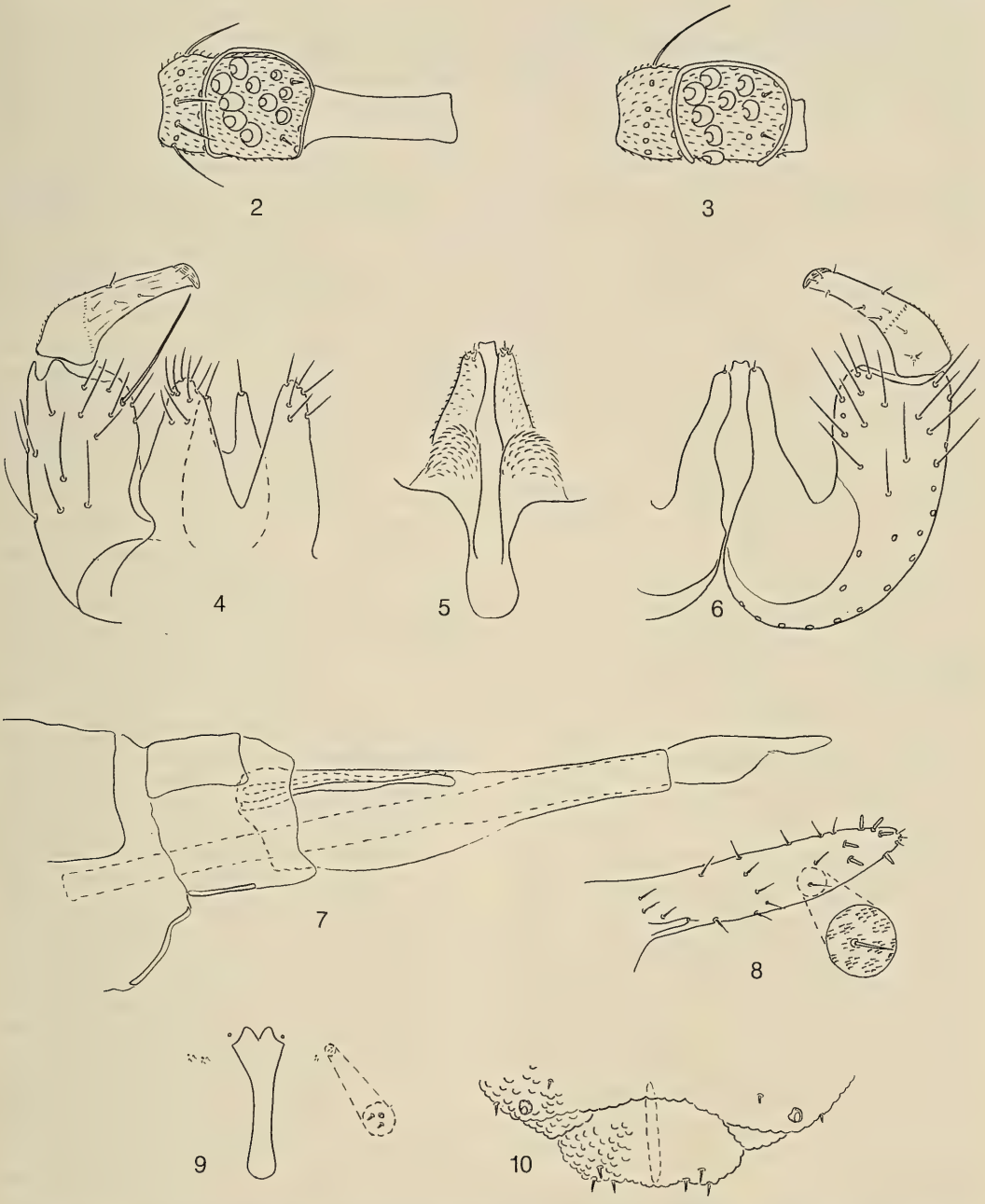
Head: Eyes 5–6 facets long at vertex; facets circular, contiguous. Vertex of occiput broadly rounded. Frons with setae and scales. Labella hemispherical, each with 8–10 setae. Palpus 4 segmented. Male antenna with 15–17 flagellomeres, the third as in Fig. 2. Female antenna with 15–16 flagellomeres, the third as in Fig. 3.

Thorax: Scutum with 2 lateral and 2 dorsocentral rows of mixed setae and scales. Scutellum with a group of setae on each side. Mesanepisternum covered with scales on dorsal third. Mesepimeron with 11–15 setae. Wing with R_5 joining C anterior to wing apex. Claws toothed, empodia as long as claws.

Male abdomen: First through fifth tergites entire, rectangular, with single, uninterrupted, posterior row of setae and scattered setae anteriorly; sixth tergite as for fifth except that anterior setal row interrupted mesally; seventh tergite unsclerotized caudomesally, with 2–3 setae posterolaterally, scattered scales laterally; eighth tergite reduced in size, bare except for anterior pair of trichoid setae. Genitalia (Figs. 4–6): cerci rounded apically, with several setae along posterior margin; hypoproct with two long narrow lobes, each with distal seta; claspettes elongate, attenuate, with dorsobasal lobes; gonocoxite cylindrical, unlobed; gonostylus cylindrical, tapered from base to apex, setulose at base, striate beyond to short distal tooth.

Female abdomen (Figs. 7–8): First through sixth tergites rectangular, with single posterior row of setae, anterior pair of trichoid setae, and almost completely covered with scales elsewhere; seventh tergite much narrower, with double row of posterior setae and scattered scales; eighth tergite much longer and divided into two elongate sclerites; distal half of ovipositor elongate, about 6 times length of sixth tergite; cerci fused, cylindrical, slightly bilaterally flattened, basal two-thirds with widely scattered, short setae, distal third with several short, thick setae, the entire surface covered with patches of short setulae; hypoproct narrow, elongate.

Larva.—First instar: white; length, 0.4–



Figs. 2–10. *Dasineura praecox.* 2, Male third antennal flagellomere. 3, Female third antennal flagellomere. 4–6, Male genitalia: 4, gonopod, cerci, and hypoproct (dorsal); 5, parameres and aedeagus (dorsal); 6, parameres, aedeagus, and gonopod (ventral). 7, Female abdomen, sixth segment to end (lateral). 8, Female fused cerci with detail of surface (lateral). 9, Third instar spatula with associated papillae, with detail of one group of lateral papillae. 10, Third instar eighth and terminal segments (dorsal).

0.6 mm.; integument smooth; spiracles on prothoracic and eighth abdominal segments. Second instar: greenish-white to white; length, 1.6–2.5 mm.; integument smooth; spiracles on prothoracic and first through eighth abdominal segments. Third instar: yellow; length, 2.5–2.6 mm; integument rugose; spiracles on prothoracic and first through eighth abdominal segments; spatula (Fig. 9) clove shaped; papillae basic for supertribe present (Gagné 1989); terminal papillae (Fig. 10) with 8 setae of equal length (2 not shown, hidden from view dorsally).

Pupal exuviae.—White. Face smooth, clypeus with two papillae at each side near base, one of each pair with short seta. Cephalic setae and prothoracic spiracles elongate. Abdomen covered dorsally with spicules, those mesoanteriorly on second to eighth segments enlarged, spinose.

Holotype.—Male, emerged X-1993 from larva collected IV-23-1993 in flower bud of *Rhododendron periclymenoides,* South Farm, Beltsville Agricultural Research Center, Beltsville, Maryland, R. J. Gagné, deposited in the USNM. Other material examined, all from *R. periclymenoides,* mounted on slides and deposited in the USNM: 7 males, 8 females, same data as holotype; 5 pupal exuviae, same data as holotype; 32 first instars, collected III-10-1994, same locality as holotype; 13 second instars, collected IV-4-1994, same locality as holotype; 8 third instars, collected 23-IV-1993, and 6 third instars, collected IV-14-1994, all same locality as holotype; 10 third instars, collected 22-IV-1994, Fern Valley, US National Arboretum, Washington, D.C. Additional specimens of all stages in alcohol in USNM.

Etymology.—The specific name *praecox* is an adjective meaning precocious, with reference to the adults' autumn flight period and early eclosion of the larvae in late winter.

Remarks.—The genus *Dasineura* is an artificial, catchall category and contains species of the tribe Oligotrophini that have four palpal segments, toothed tarsal claws, a shortened R_5 wing vein that meets the costa anterior to the wing apex, and the full basic complement of larval papillae for the tribe. The new species resembles in some ways *Dasineura oxycoccana* (Johnson), a species that infests buds of *Vaccinium* species. The male and female genitalia of both species are superficially similar. The female cerci of both species bear several thick, subapical, sensory setae. *Dasineura oxycoccana,* however, is a smaller species with a wing length of only 1.2–1.4 mm and only 13–14 antennal flagellomeres. The two species differ greatly in their biology: while *D. praecox* has one generation per year and its adults appear in autumn, *D. oxycoccana* has two or more generations per year and its adults appear in spring and summer (Gagné 1989).

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REDUVIIDAE (HETEROPTERA) COLLECTED BY FOGGING THE FOREST CANOPY IN PERU

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Abstract.—Species of Peiratinae, Salyavatinae, Stenopodainae, Hammacerinae, and Ectrichodiinae collected by fogging the forest canopy in Peru are discussed. A new species of Hammacerinae, ***Homalocoris nermini,*** and a new species of Ectrichodiinae, ***Daraxa (Daraxa) crena,*** are described.

Key Words: Peru, fogging, forest canopy, Homalocoris, Daraxa, Reduviidae

All of the 19 subfamilies of reduviids known from the Americas occur in the Neotropical Region, 10 of these ranging into the Nearctic. Specimens of seven subfamilies were collected by fogging the forest canopy, in Madre de Dios, Rio Tambopata Reserve, 30 kms SW of Puerto Maldonado, 290 m, 12°50′S, 069°, 17′W. This was part of a project sponsored by the Smithsonian Institution, Washington, D.C., with Terry Erwin as principal investigator.

Represented by one specimen only in these collections are the Ectrichodiinae (*Daraxa* (*Daraxa*) *crena,* n. sp.), Hammacerinae (*Homalocoris nermini,* n. sp.), Peiratinae (*Rasahus albomaculatus* (Mayr)), Salyavatinae (*Salyavata cornuta* Wygodzinsky) and a Stenopodainae nymph. The new species are described below. The Harpactorinae were represented by 63 specimens, the highest number, with four nymphs among them. The Emesinae were second with 41 specimens, including 15 nymphs. At World level, according to the number of species in the subfamily, the last two are the first and third largest (Maldonado 1990). The last two subfamilies will be treated in subsequent papers.

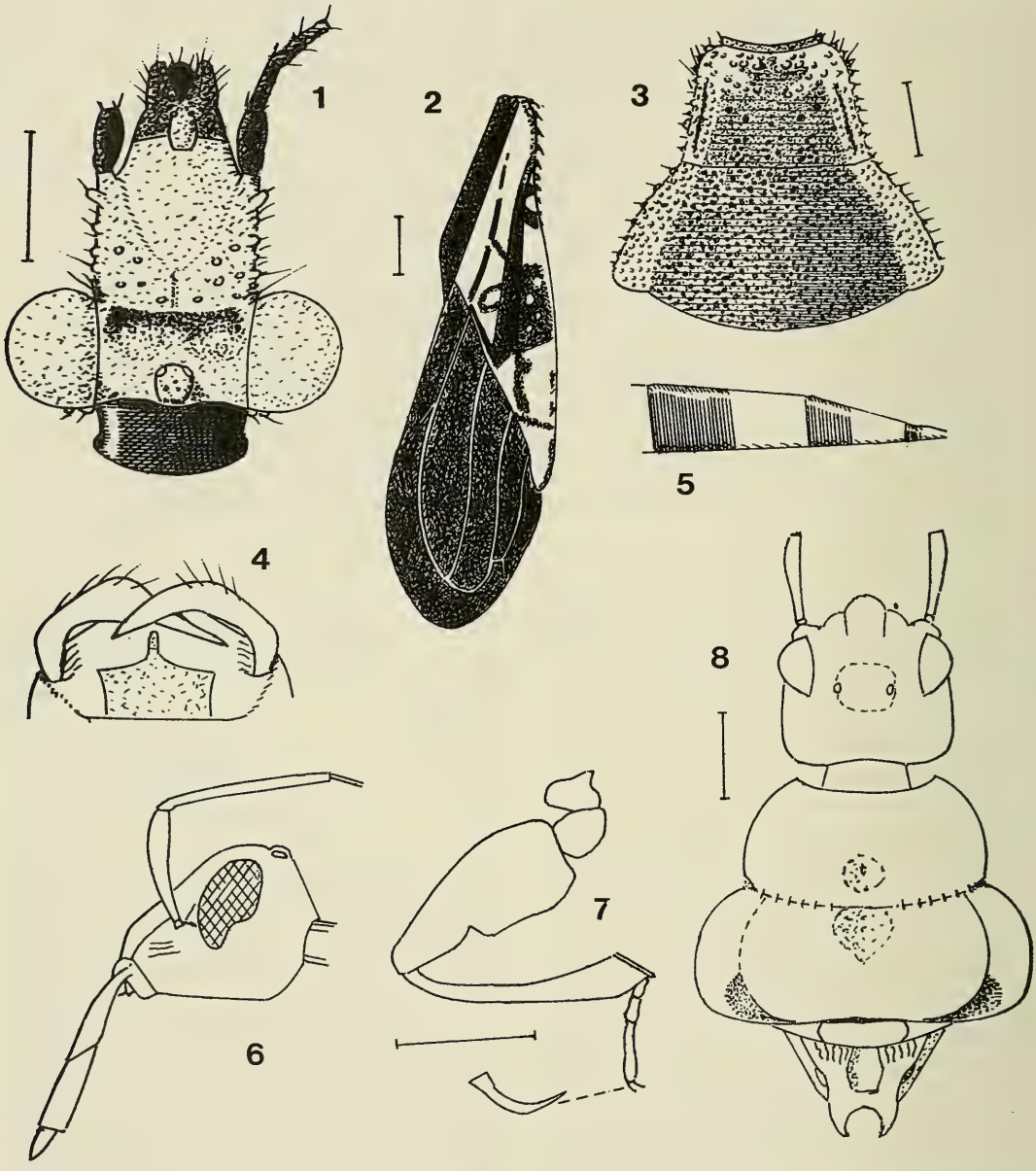
Setiferous tubercles are abbreviated s-tubercles in the text. Types are deposited in the National Museum of Natural History at Washington, DC (NMNH). Measurements are in mm.

Homalocoris nermini Maldonado, New Species

(Figs. 1–4)

Male: Overall color dark brown, ornamented with ochraceous. Antennae, head dorsally brown; eyes red; rostrum stramineous. Pronotum (Fig. 3): black; anterior lobe—rows of coarse, globular s-tubercles anteriorly and 2 + 2 marginal fasciae ochraceous; posterior lobe with margins ochraceous; scutellum black. Legs: coxae amd trochanters ochraceous; profemur black dorsally, tibia and first two tarsal segments ochraceous, femur underneath, third tarsal segment black; middle leg blackish brown, femur slightly darker above, tarsal segments stramineous, third segment black apically; hind leg ochraceous, femora with basal, midlength and apical black annuli. Fore wing (Fig. 2): clavus and membrane blackish, corium stramineous with extensive, blackish ornamentation, veins of membrane ochraceous.

Abdominal sterna and hemelytra smooth,



Figs. 1–8. 1–4, *Homalocoris nermini,* male holotype. 1, Head, dorsal view. 2, Hemelytron, dorsal view. 3, Pronotum, dorsal view. 4, Male genitalia, external, dorsal view. 5–8, *Daraxa* (*Daraxa*) *crena,* male holotype. 5, First three connexival segments, dorsal. 6, Head, lateral view. 7, Fore leg, frontal view. 8, Head, pronotum, and scutellum, dorsal view. All scale lines equivalent to 1.00.

sterna with abundant, moderately long decumbent setae. Remaining parts of body densely covered with s-tubercles with moderately large globular bases, the setae longer than the corresponding base except on disc of pronotum where setae are shorter.

Head (Fig. 1): Length 2.87, width across eyes 2.37; eyes almost pedunculate, slightly upraised thus surpassing level of vertex, not reaching ventral surface, width 0.62; interocular space 1.00, anteocular space to apex of antennophore 0.62, minute postocular re-

gion; ocellar callus small, anterior to level of posterior margin of eyes. Jugae divergent, thick as seen from above, slightly deflexed and flattened ventrally, slightly surpassing base of clypeus. Antenna: length of segments I, 0.62; II, 5.50, formed by numerous short, pseudosegments, III and IV partially broken. Rostral segments: lengths I, 1.37; II, 1.12; III, 0.75, slightly curved, sparsely setose. Pronotum (Fig. 3): anterior lobe width 2.75, length 1.62; posterior lobe humeral width 4.12, length 2.12, humeral angles rounded. Mesoscutellum 0.31 long, scutellum length 1.62, width 0.62, prongs or spines of scutellum apart by a basal width. Legs: lengths of femora 3.75, 3.75, 8.12, fore and middle incrassate; tibiae 3.12, 3.50, 7.25, spongy fossa on apex of anterior; tarsi 1.12, 1.12, 2.00, straight, slender. Fore wings (Fig. 2): length 11.87, almost reaching abdominal apex, width 3.75. External genitalia as in Fig. 4. Total length of body 20.50 mm.

Holotype.—Male, PERU, Madre de Dios, Rio Tambopata, 30 kms SW of Puerto Maldonado, fogging forest canopy, 14 September 1984. Terry Erwin et al. collectors, in NMNH.

The black legs and the ochraceous clavus run *Homalocoris nermini* in Maldonado and Santiago Blay's key (1992) to couplet 5, together with *H. binotatus* Champion and *H. maculicollis Stal.* The relatively large size, the blackish, extensive, irregular ornamentation on the corium, and the ochraceous lateral margins of the pronotum separates *H. nermini* n. sp. from irs congeners. The trivial name is in memory of Nermin Divovic, a 7-year old Sarajevan boy, an innocent victim of warfare.

Daraxa (*Daraxa*) *crena* Maldonado, New Species
(Figs. 5–8)

Female: Overall color dark brown and black, ornamented with ochraceous. Head black, eyes gray, rostrum brown fading to stramineous after midlength of second segment, first two antennal segments brown, remaining segments pale brown with gray intersegmental areas. Pronotum; anterior lobe black dorsally and laterally, polished, smooth; pleurae brown, prosternum gray, meso- and metasternum blackish, scutellum black. Leg (Fig. 7): coxae and trochanters stramineous; femora mostly blackish, anterior femora with small, postbasal and preapical ochraceous areas, middle and hind femora with more extensive postbasal stramineous areas; anterior and middle tarsi brown, hind with first and base of third segment stramineous. Fore wing mostly brown, humeral angle, base of pterostigma and outer apical angle of corium yellowish, inner margin of membrane inconspicuously grayish. Abdominal sterna ochraceus medially, black laterally; connexival segments (Fig. 5) above and below with basal half stramineous, apical half black.

Head (Figs. 6, 8): Length 0.93, width across eyes 1.12, interocular space 0.62, width of eye 0.25, dorsal length of eye 0.43, postocular space 0.37, eyes close to but not reaching upper margin of head, vertex slightly convex, frons sloping to tylus; ventrolaterally behind eyes slightly swollen, as wide as across eyes. Antennal segments: I, 0.75; II, 1.25; III, 0.62; IV, 0.50; V–VII, 0.25; VIII, 0.31; first two with fine setae about as long as diameter of corresponding segment, setae on III and IV slightly longer, last segments with scarce setae, 3 or 4 times as long as diameter of corresponding segment. Rostrum (Fig. 6): straight, glabrous, length of segments I, 0.62; II, 0.25; III, 0.2; gradually thickening to apex of II, III short, triangular. Collum 0.12. Pronotum (Fig. 8): smooth, glabrous, median sulcus of anterior lobe reduced to a shallow fovea before transverse constriction, length 0.75, width 1.68; posterior lobe length 0.75, humeral width 2.25, median sulcus reduced to a shallow fovea on anterior third, lateral and humeral areas slightly swollen, with a small depression before humeral angles; margins conspicuously rounded, transverse constriction crenulate to base of acetabula; basal margin shallowly biconcave above scutel-

lum. Mesopleuron smooth, metapleuron vertically corrugate. Legs: femora 1.75, 1.65, 2.18; tibiae 1.62, 1.68, 2.50; tarsi 0.62, 0.75, 0.87, femur of anterior leg incrassate, about as thick as length of eye on lateral view, ventral margin with a conspicuous notch (Fig. 7), unarmed, tibia slightly curved, swollen toward apex, spongy fossa on apical slanted face; middle leg with femora half as thick as fore (0.50:0.25), tibia straight, very slightly swollen apically; hind leg straight, femur 0.25 thick. Mesoscutum exposed, 0.31 long; scutellum 0.75 wide, 0.32 long, prongs incurved, apices apart by more than a prong basal width, S-curved carinae extending to apices of prongs. Hemelytra length 4.75, width 1.00. Connexivum exposed, margin of individual segments straight; abdominal sterna smooth ventrally, irregularly finely corrugate before connexivum, sutures obsolete, crenulate on lateral black areas only; spiracles small, round, close to anterior margin of corresponding sternum; length of abdomen 4.78, width 2.81.

Holotype.—Female, PERU, Madre de Dios, Rio Tambopata Reserve, 30 kms SW of Puerto Maldonado, 290 m, 12 50 S, 069 17 W, 25 February 1984, fogging forest canopy, Terry Erwin et al. collectors; in NMNH.

Daraxa (*Daraxa*) contains 9 species (Carpintero 1980). *D.* (*D.*) *crena* n. sp. differs from these by the following characters: length 7.00, pronotum not pitted, anterior and posterior lobes of pronotum of equal length, not ornamented with red, and by the unique notch on the fore femur. The trivial name *crena* (Latin, *cren-*) means cut.

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PLACEMENT OF *HELOPICUS RICKERI* STARK IN *HYDROPERLA* FRISON (PLECOPTERA: PERLODIDAE) WITH THE DESCRIPTION OF THE ADULT FEMALE, NYMPH, AND EGG AND A CLADISTIC ANALYSIS OF *HYDROPERLA*

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Abstract.—*Helopicus rickeri* Stark is transferred to *Hydroperla,* **new combination**. The adult female, nymph, and egg of this species is described and illustrated for the first time. Cladistic analysis of the species in *Hydroperla* indicates that *H. rickeri* and *H. crosbyi* (Needham and Claassen) form a monophyletic group within the genus.

Key Words: Plecoptera, stoneflies, Perlodidae, *Hydroperla rickeri, Helopicus,* Nearctic

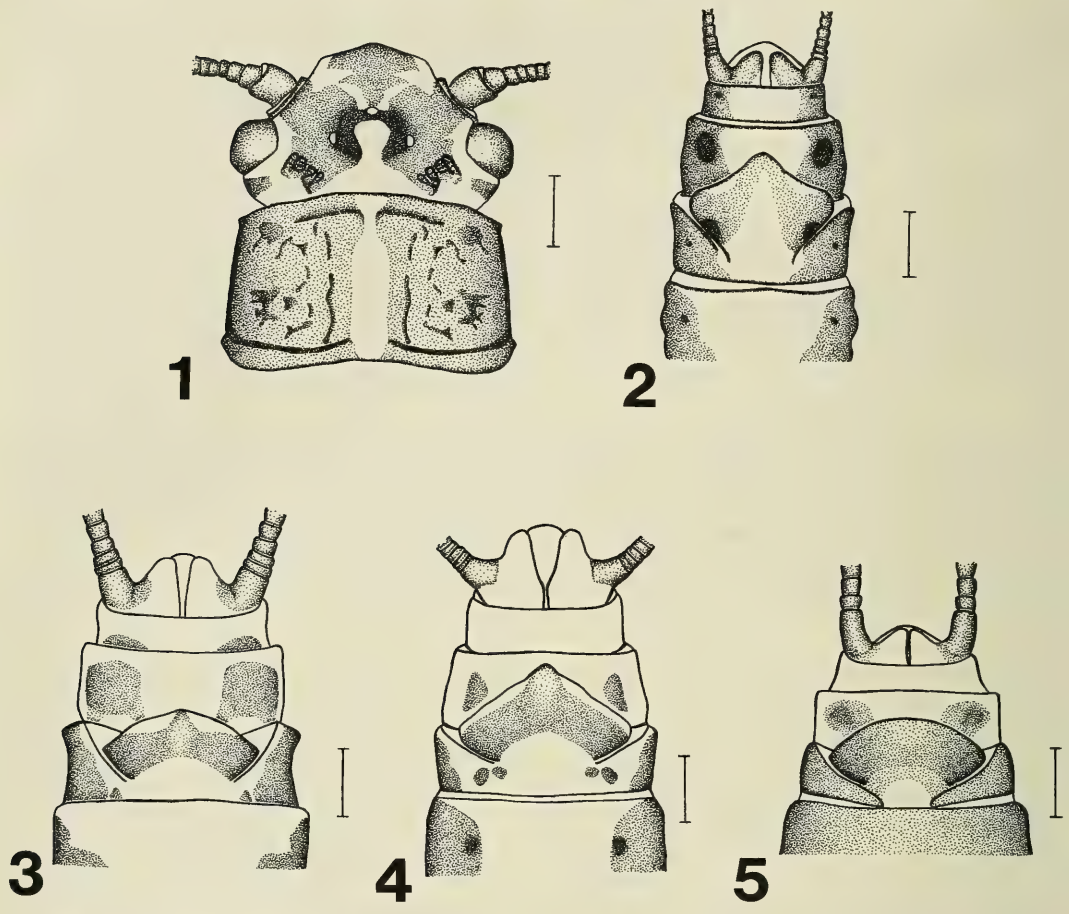
Stark (1984) described *Helopicus rickeri* from a single male specimen. The generic placement, however, of this distinctive species was speculative. Although he noted that *H. rickeri* differed from other species in *Helopicus* in having two posteroventral spines on the epiproct, Stark tentatively assigned it to this genus because the male lacked lateral stylets, exhibited a similar meso- and metasterna pigment pattern, and displayed structural correspondence with respect to the mesosternal Y-ridge. He concluded that the resolution of the generic placement of *H. rickeri* would have to await the finding of the female and nymph. The recent collecting of these life history stages as well as that of the egg has given me the opportunity to review the generic assignment of *H. rickeri.* In this paper I transfer *H. rickeri* to *Hydroperla* Frison, describe the female, nymph, and egg, and assess, using parsimony analysis, its cladistic relationship with other species in this genus and to that of *Helopicus* Ricker. To facilitate identification of species within *Hydroperla,* I also furnish figures of the females of *H. phormida, H. fugitans,* and *H. crosbyi,* as they were not provided in Ray and Stark's (1981) review of this genus.

Hydroperla rickeri (Stark), NEW COMBINATION
(Figs. 1, 2, 6–13)

Description.—*Male:* As described by Stark (1984). Distinctive epiproct excavated and hood-like apically; tip, in profile, forming a strongly backward directed hook; two elongate spines project from the posteroventral surface (Fig. 7). Lateral stylets absent.

Female: Macropterous. Length of body 17–23 mm; length of forewings 19–23 mm. General body color dark brown to black, patterned with yellow. Dorsal color pattern of head and pronotum as in Fig. 1. Subgenital plate triangular, approximately half as long as rest of sternite (Fig. 2). Sides of S9 and S10 dark, mesal areas yellow (Fig. 2).

Nymph: Length of body mature male 15.5–17 mm; length of body mature female 19–21 mm. General color dull olive green (yellowish brown in alcohol) with dark brown markings (Fig. 6). Fronto-clypeal region, anterior to posterior, bearing four



Figs. 1–5. 1, *Hydroperla rickeri,* adult head and pronotum. 2–5, *Hydroperla,* female terminalia, ventral view. 2, *H. rickeri.* 3, *H. crosbyi.* 4, *H. fugitans.* 5, *H. phormida.* Scale lines = 1 mm.

transverse bands: a narrow light band followed by a broad dark band, then, just anterior to the median ocellus, a broad light band, and, between the antennal bases, a wide M shaped band enclosing three light circular spots. Occiput, between the compound eyes, bearing two incompletely enclosed light oval spots patterned with darker lines. Pronotal margins dark; disc with contrasting light and dark areas. Meso- and metathoracic nota also with a contrasting light and dark pattern (see Fig. 6). Legs, antennae, cerci, and abdominal terga 1–9 all of uniformally light pigmentation. Mouthparts similar to those described and figured for *Hydroperla crosbyi* (Needham and Claassen) by Stewart and Stark (1988), except that the mandibular teeth are bluntly, rather than sharply, pointed (Figs. 8–10).

Egg: Length 0.73 mm; width 0.49 mm. General shape oval; in cross-section triangular (Figs. 11, 12). Collar stalked and bearing longitudinal ridges (Fig. 13). Anchor mushroom-shaped (Figs. 11, 13). Chorionic surface partitioned by elevated ridges that form irregularly shaped hexagonal cells, each enclosing numerous punctations.

Specimens examined.—TENNESSEE: Trousdale Co., Rocky Creek, Rt. 25, 22 March 1990, C. H. and C. P. Nelson, 1 male; 24 March 1991, C. H., C. P. and E. S. Nelson, 1 male, 2 exuviae; 28 March 1991, C. H. and C. P. Nelson, 5 males, 1 female, 1 nymph, 6 exuviae; 2 April 1991,

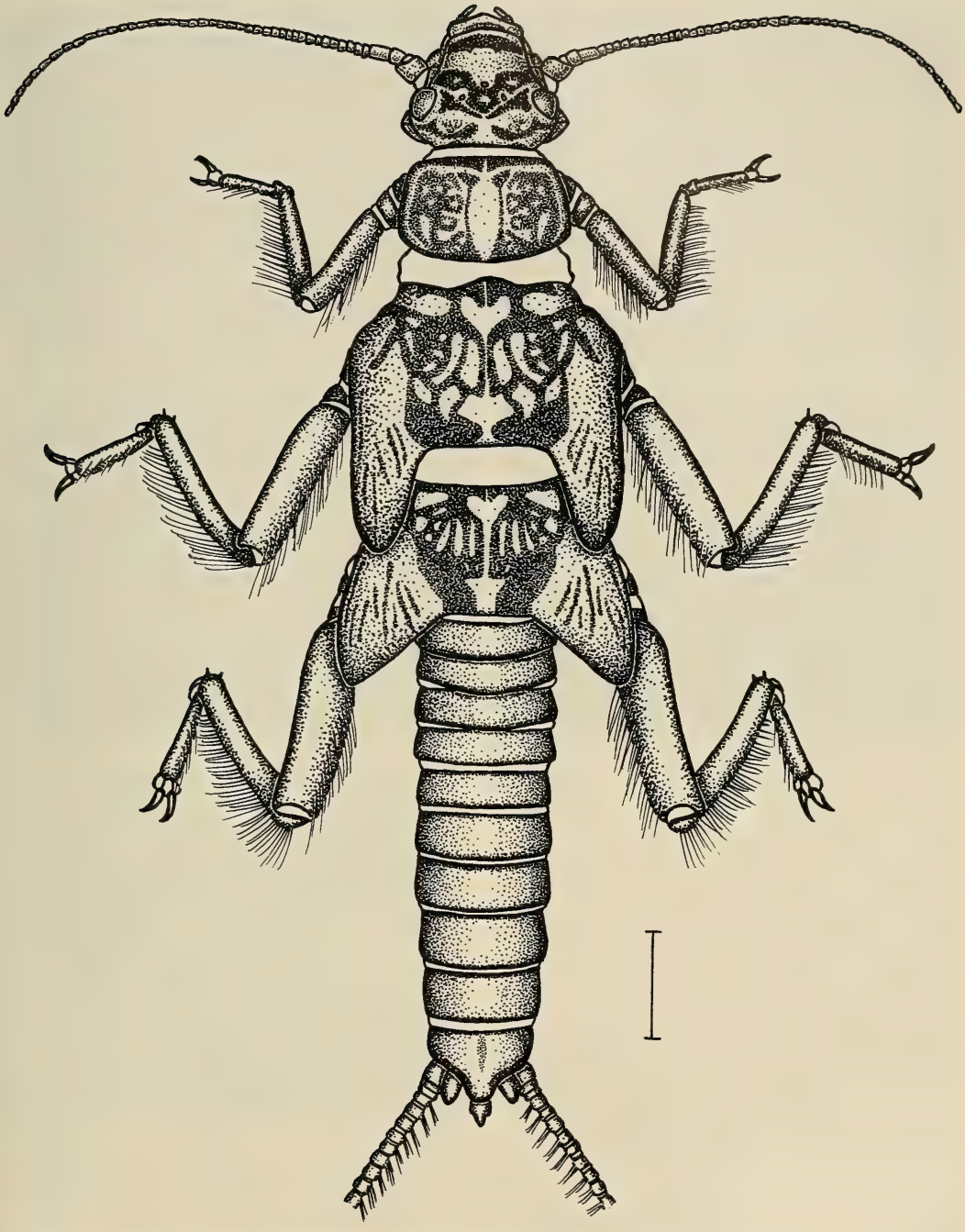
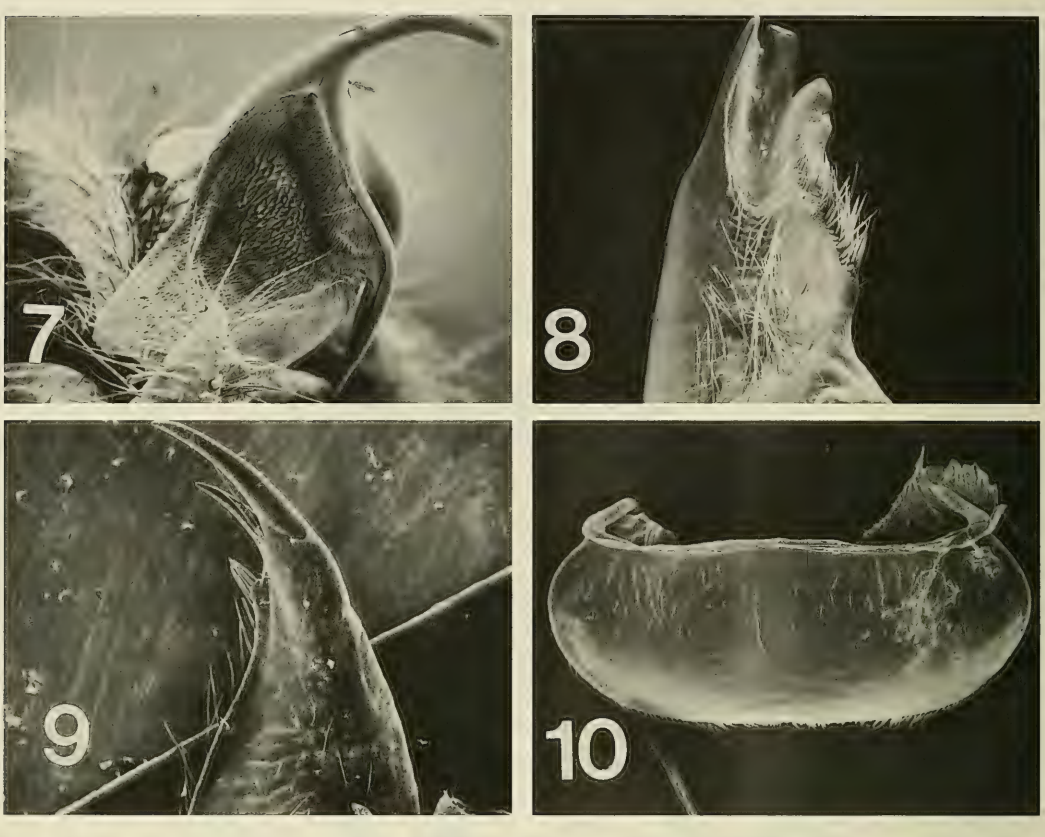


Fig. 6. *Hydroperla rickeri,* mature nymph habitus. Scale line = 2 mm.

C. H. and E. S. Nelson, 9 males, 4 females, 1 nymph, 3 exuviae; 7 April 1991, C. H. and E. S. Nelson, 7 males, 7 females, 1 nymph, 12 exuviae; 5 April 1992, C. H. and E. S. Nelson, 18 males, 4 females, 9 nymphs, 22 exuviae; 8 April 1993, C. H. Nelson, 1 male; 13 April 1994, 1 male, 1 female; tributary of Rocky Creek, Rt. 25,



Figs. 7–10. *Hydroperla rickeri.* 7, Male epiproct (150×). 8, Nymphal mandible (150×). 9, Nymphal lacinia (150×). 10, Nymphal labrum (150×).

28 March 1991, C. H. and C. P. Nelson, 2 exuviae; 8 April 1993, C. H. Nelson, 7 exuviae; 1 April 1994, C. H. Nelson, 1 male; 13 April 1994, C. H. Nelson, 2 females (reared), 2 exuviae; Little Goose Creek, Rt. 25, 22 March 1990, C. H. and C. P. Nelson, 1 male; 28 March 1991, C. H. and C. P. Nelson, 2 exuviae; Second Creek, Sulphur College Road, 24 March 1991, C. H., C. P. and E. S. Nelson, 2 exuviae; 28 March 1991, 5 exuviae; 8 April 1993, C. H. Nelson, 2 exuviae.

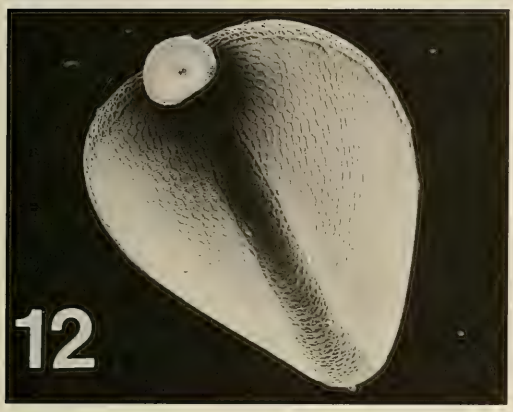
Remarks.—*Hydroperla rickeri* and all others in this genus can be distinguished from species in *Helopicus* and other Perlodini genera by the following combination of features: (1) anterodorsal surface of the apex of the male epiproct appearing excavated, (2) posteroventral surface of the apex of the male epiproct with two downward directed spines, (3) transverse dark M band of nymphal fronto-clypeal region with 3 light spots, (4) nymphal mandible with 4 teeth, (5) teeth of nymphal mandible without serrations, (6) nymphal lacinia with outer patch of setae, (7) egg collar without 3 short spike-like processes.

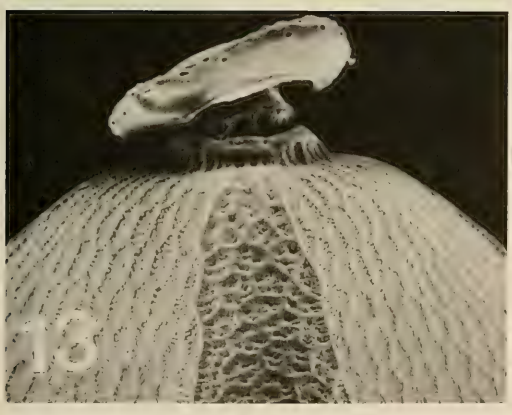
This species is only known from small to mid-sized streams of the Cumberland Plateau of Tennessee. Other stonefly species collected with *H. rickeri* include *Clioperla clio* (Newman) and *Amphinemura nigritta* (Provancher).

Key to the Species in *Hydroperla* Males

(Males of *H. crosbyi, H. fugitans,* and *H. phormida* are illustrated by Ray and Stark, 1981)

1. Epiproct tip, in profile, forming a strongly backward directed hook (Fig. 7) 2





Figs. 11–13. *Hydroperla rickeri* egg. 11, Whole egg, lateral (150×). 12, Whole egg, oblique dorsal (150×). 13, Detail of anchor and collar (500×).

– Epiproct tip, in profile, somewhat erect 3
2. Lateral stylets present; spines projecting from posteroventral surface of epiproct small, less than ½ as long as apical hook . . . . . *H. crosbyi* (Needham and Claassen)
– Lateral stylets absent; spines projecting from posteroventral surface of epiproct elongate, about as long as the apical hook (Fig. 7) . . . . . *H. rickeri* (Stark)
3. Epiproct anterodorsal surface with a small forward directed barb projecting from the margin of each side . . . . . *H. fugitans* (Needham and Claassen)
– Epiproct anterodorsal surface lacking any forward directed barbs, margin of each side smoothly contoured . . . . . *H. phormida* Ray and Stark

Females

1. Head with light pigment bordering all or nearly all of dorsal margin of eye (Fig. 1); abdominal sternum 10 with a dark pigment spot or area on each side (Figs. 2, 3) 2
– Head with dark pigment bordering all or nearly all of the dorsal margin of eye; abdominal sternum 10 without dark pigment spots or areas (Figs. 4, 5) 3
2. Postocular areas of occiput with a dark pigment spot (Fig. 1); subgenital plate triangular and about one half as long as rest of sternite (Fig. 2) . . . . . *H. rickeri* (Stark)
– Postocular areas of occiput lacking a dark pigment spot; subgenital plate rounded and about one third as long as rest of sternum (Fig. 3) . . . . . *H. crosbyi* (Needham and Claassen)
3. Abdominal sterna 2–7 with a broad mesal light pigmented band; subgenital plate triangular (Fig. 4) . . . . *H. fugitans* (Needham and Claassen)
– Abdominal sterna 2–7 uniformly darkly pigmented; subgenital plate rounded (Fig. 5) . . . . . *H. phormida* Ray and Stark

Nymphs

1. Dark pigment band of anterior fronto-clypeal region transverse and broad (Fig. 6); abdominal terga 1–9 each with uniform light pigmentation or with a transverse dark pigment band on the anterior half 2
– Dark pigment band of anterior fronto-clypeal region consisting of two dark pigment spots or four dark pigment patches, two mesal and two lateral, connected by a narrow band; abdominal terga 1–9 each with a row of small dark pigment spots 3
2. Abdominal terga 1–9 each with a transverse dark pigment band on anterior half . . . . . *H. crosbyi* (Needham and Claassen)
– Abdominal terga 1–9 each uniformly lightly pigmented (Fig. 6) . . . . . *H. rickeri* (Stark)
3. Dark pigment band of anterior fronto-clypeal region consisting of two dark pigment spots; anterior margin of labrum not expanded mesal-

Table 1. Character data matrix for *Hydroperla* species.

Taxa	Characters																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Hydroperla crosbyi	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	0	1	1
Hydroperla fugitans	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	1	0	1
Hydroperla phormida	0	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0
Hydroperla rickeri	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1	1	1	1	1	1	0	1
Helopicus	1	1	(01)	1	1	1	0	1	(01)	0	(01)	0	0	0	0	0	0	0	0	(01)	0	0

ly into a central lobe . . . . . .
. . . . . .*H. fugitans* (Needham and Claassen)

– Dark pigment band of anterior fronto-clypeal region consisting of four dark pigment patches, two mesal and two lateral, connected by a narrow band; anterior margin of labrum expanded mesally into a central lobe . . . . . .
. . . . . .*H. phormida* Ray and Stark

Cladistic Analysis

For this analysis, I selected *Helopicus* as the outgroup to assess cladistic relationships of *H. rickeri* and its congeners. *Helopicus,* widely distributed in eastern North America, includes three species and is regarded by Stark and Ray (1983) as being most closely related to *Hydroperla.* Twenty two two-state characters listed below and in Table 1 were analyzed using PAUP 3.1.1 (Swofford 1993) and MacClade 3.0 (Maddison and Maddison 1992):

1. Three short spike-like processes of egg collar present (0), or absent (1).
2. Transverse dark pigment band of nymphal anterior fronto-clypeal region uniformally broad (0), or broken up, consisting of spots or patches, or is absent (1).
3. Transverse M band of nymphal fronto-clypeal region with anterior margin M-shaped (0), or straight (1).
4. Transverse M band of nymphal posterior frons interrupted by three light spots (0), or not interrupted (1).
5. Nymphal mandible lacking distinct serrations with teeth (0), or with serrations (1).
6. Right nymphal mandible with 4 teeth (0), or with 5 teeth (1).
7. Teeth of nymphal mandible sharply pointed (0), or bluntly pointed (1).
8. Outer patch of setae on nymphal lacinia present (0), or absent (1).
9. Mesal area of nymphal labium strongly produced (0), or weakly or not produced (1).
10. Dorsal eye margin of adult bordered by dark pigment (0), or light pigment (1) for all or nearly all of its distance.
11. Transverse dark band of adult mesosternum not interrupted (0), or interrupted (1) by an area of light pigment on either side of the midline.
12. Male hemitergal lobes broadly rounded (0), or thumb-like (1).
13. Male lateral stylets absent (0), or present (1).
14. Paired barbs on posteroventral surface of male epiproct absent (0), or present (1).
15. Paired barbs on posteroventral surface of male epiproct much shorter than (0) or about as long as (1) apical hook.
16. Apex of male epiproct excavated and hood-like (0), or cylindrical or flattened (1).
17. Acute or truncate forward directed projections of male epiproct absent (0), or present (1).
18. Forward directed projections of male epiproct little expanded (0), or greatly expanded (1).
19. Backward directed hook at apex of male epiproct absent (0), or present (1).

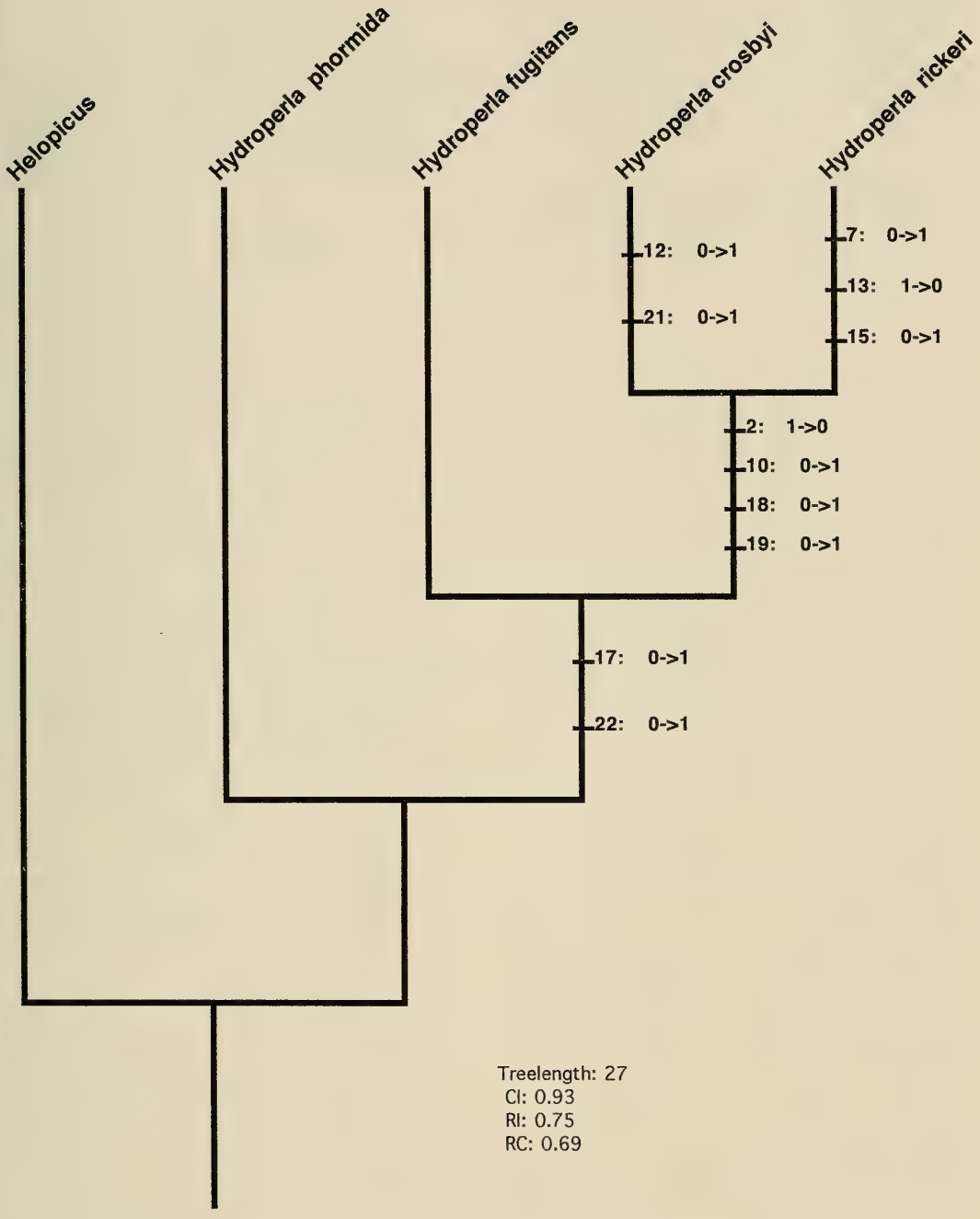


Fig. 14. Cladogram of the species of *Hydroperla* with the outgroup *Helopicus* that results from using the branch and bound option of PAUP to analyze the character matrix in Table 1. Character numbers associated with tick marks indicate unambiguous changes.

20. Female subgenital plate rounded (0), or triangular (1).
21. Female subgenital plate one half as long as rest of sternite (0), or less than one quarter as long as the rest of sternite (1).
22. Posterior margin of female subgenital plate uniformly dark pigmented (0), or interrupted with an area of light pigmentation on either side of the midline (1).

A single most parsimonious tree (Fig. 14) was found using the branch and bound option of PAUP. The tree length was 27, the Consistency Index (CI) was 0.93, the Retention Index (RI) was 0.75, and the Rescaled Consistency Index (RC) was 0.69. *H. rickeri* together with *H. crosbyi* form a monophyletic group within the *Hydroperla* clade. Although Stark (1984) suggested that the similarity of the epiprocts of *H. rickeri* and *H. crosbyi* males was superficial, the tree generated here indicates that this similarity reflects an underlying close phylogenetic relationship.

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A NEW SPECIES OF *CYAMOPS* MELANDER (DIPTERA: PERISCELIDIDAE) FROM BRAZIL, WITH DISTRIBUTIONAL NOTES ON ANOTHER SPECIES

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Abstract.—A new species of the periscelidid genus *Cyamops* Melander, ***C. sabroskyi,*** is described from Brazil (Rio de Janeiro). Its sister-group relationship with *C. neotropicus* is hypothesized. Discovery of *C. americus,* previously known only from Mexico and Costa Rica, is reported from Guyana.

Key Words: Diptera, Periscelididae, *Cyamops,* Neotropical Region, Brazil

In a recent revision of the periscelidid genus *Cyamops* Melander (Baptista and Mathis 1994), we recognized eight New World species, including four that were newly described. Two of these, *C. fasciatus* Baptista and Mathis and *C. neotropicus* Baptista and Mathis, occur in Brazil. Herein we describe a third species from Brazil that was recently collected in the state of Rio de Janeiro. We also provide locality data on the discovery of *C. americus* Baptista and Mathis in Guyana.

Methods.—The descriptive terminology, with the exceptions noted in Baptista and Mathis (1994), is that published in the Manual of Nearctic Diptera (McAlpine 1981). As a complete description for the genus *Cyamops* was published recently in the above cited work, the generic characters will not be repeated here, and the format for the species description likewise adheres to Baptista and Mathis (1994).

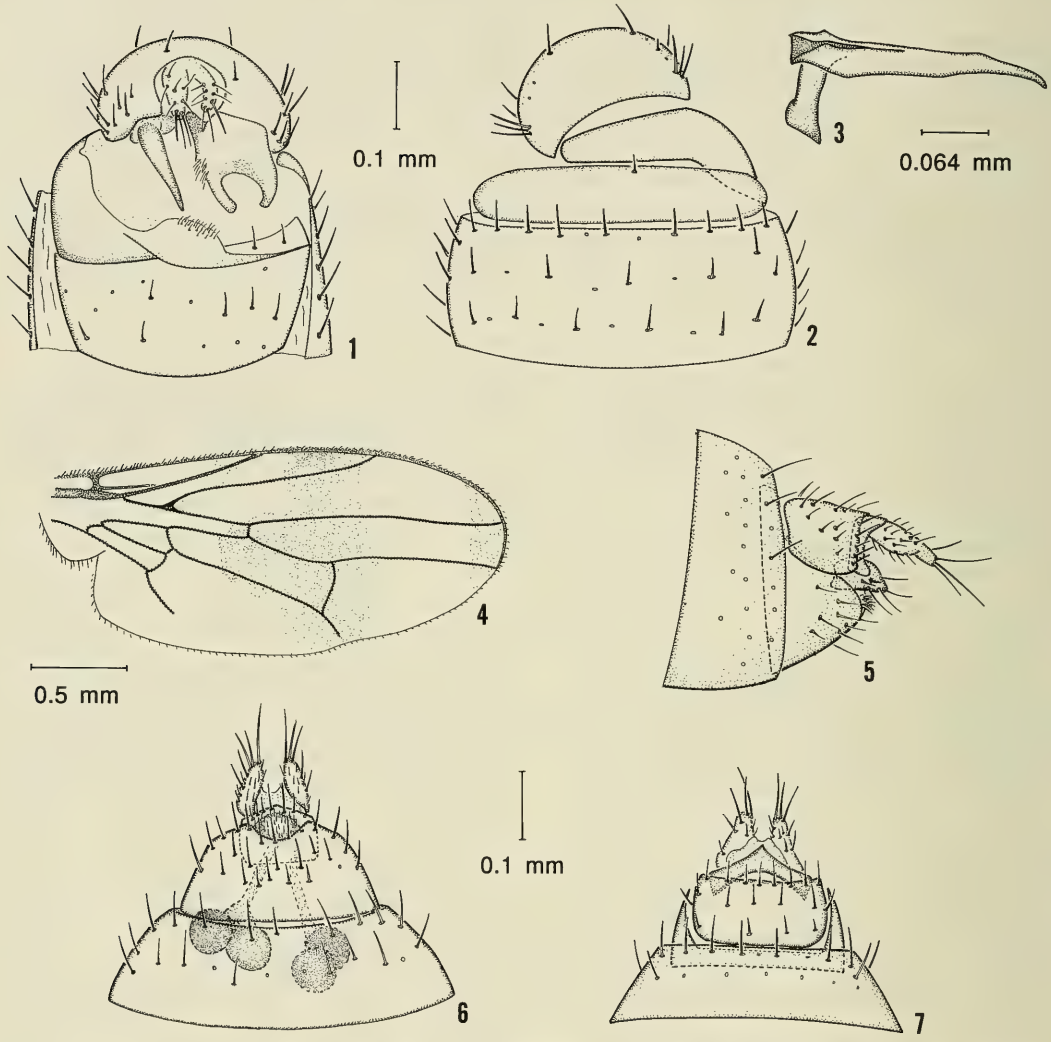
Cyamops sabroskyi Baptista and Mathis, New Species

(Figs. 1–7)

Description.—Small flies, with general characters of American species of *Cyamops* as noted by Baptista and Mathis (1994:5–6). Adult ♂ length 2.4 mm; wing length 2.2 mm; wing width 0.9 mm (only holotype measured). Adult ♀ length 2.7–3.0 mm; wing length 2.70–2.80 mm; wing width 1.10–1.12 mm (3 ♀ measured).

Head: Frons and ocellar tubercle subshiny, partially microtomentose, microtomentum denser in depressed area; antenna with dorsal ½ mostly brown; facial region mostly yellow, sparsely microtomentose medially; clypeus and palpus pale yellow; face shallowly and vertically arched, not angulate; facial carina narrow, slightly widened anteriorly; eye bearing sparse interfacetal setulae. Chaetotaxy: Inner fronto-orbital setae nearly parallel to slightly divergent; fronto-orbits thinly setulose; arista with 10:3 rays, dorsobasal rays not clearly bifurcate; peristomal setae 8–9.

Thorax: Halter mostly white, brown at base; mesonotum slightly longer than large; scutellum trapeziform, disk flattened. Chaetotaxy: dorsocentral setae 0 + 1, subequal in length to the 1st scutellar setae; mesonotal setulae not much developed; scutellar setae 2, the basal pair about ½ the length of the apical; anepisternum setulose posteri-



Figs. 1–7. *Cyamops sabroskyi* (holotype). 1, Abdomen of ♂, ventral view. 2, Same, dorsal view. 3, Ejaculatory apodeme, (holotype), lateral view. 4, Wing (female paratype). 5, Abdomen of ♀ and terminalia, lateral view. 6, Same, ventral view. 7, Same, dorsal view.

orly. Legs: Mostly yellow; mid and hind coxae brown; mid femur with apical ½ and hind femur with apical ¾ brown; apical and subapical tarsomeres of each leg brown; spinelike setulae 8, not well differentiated, brown. Wing (Fig. 4): Mostly hyaline but with distinct brown pattern; central, irregular transverse stripe comparatively narrow, not connected with apical stripe anteriorly; a brown mark near apex of vein R_1 present, but inconspicuous; costal vein ratio I:1.04–1.24 (slide-mounted wing 1.04), costal vein ratio II:2.94–3.12 (slide-mounted wing 3.12), wing ratio: 2.42–2.57 (slide-mounted wing 2.42).

Abdomen (Figs. 1–2): Male 7th tergite as long as 6th, both tergites almost without setae; sternites 6-7 with posterior process evenly rounded, somewhat shallow, with median extension. Male terminalia as follows (Figs. 1, 3): right surstylus large, about as wide as long, apical margin hook-shaped in ventral view; left surstylus narrow, gradually tapered to point, length lon-

ger than right; hypandrial projection apparently absent; ejaculatory apodeme (Fig. 3) moderately large, almost equal to combined length of 6th and 7th tergites, in lateral view hatched shaped, extended process parallel sided, in dorsal view somewhat tear drop in shape with basal margin truncate and apical margin with nipplelike projection.

Female: Head: mesofacialia and gena dark brown, strongly microtomentose, silver; facial carina shiny, sparsely microtomentose; clypeus shiny brown; palpus brown; antenna dorsally infuscate; face in profile angulate.

Thorax: Setae and setulae of mesonotum typically stronger and longer than in the male. Legs: Coxae and femora dark brown, hind tibia infuscate at apical ⅓, apices with a yellowish ring; apical and subapical tarsomeres of each leg brown.

Abdomen and terminalia (Figs. 5–7): 6th and 7th segments well delimited dorsally; 8th sternite small, difficult to discern, but completely separate from 7th segment; 9th sternite almost rectangular, slightly wider than long; two pairs of equal spermathecae present.

Type material.—The holotype male is labeled "BRAZIL. RJ. Rio de Janeiro, Paineiras/A. Baptista, R. Baptista, 30 Oct 1994; [date handwritten across left side of label]; HOLOTIPO ♂ [printed except for "♂"; red]/*Cyamops sabroskyi* A. Baptista & W. N. Mathis." The holotype is double mounted (glued to a point), is in moderately good condition (abdomen removed, dissected, parts in an attached microvial), and is deposited in the MZUSP. Paratypes: Same label data as the holotype (3 ♀; 1 ♀ with wing and abdomen removed, wing slide-mounted, abdomen attached in a microvial; others in good condition, MZUSP).

Distribution.—*Cyamops sabroskyi* is known only from the type locality in Rio de Janeiro, Brazil.

Etymology.—This species is named to honor Dr. Curtis W. Sabrosky, who has contributed to our knowledge of New World *Cyamops* (Sabrosky 1958, 1965) and who encouraged our research on this fascinating and colorful genus.

Remarks.—This species keys to *C. neotropicus* Hennig in our "Key to the New World species of *Cyamops*" (Baptista and Mathis 1994). The shape of the male sternites 6 and 7 and of the aedeagal apodeme (hatchetlike) seems to be a synapomorphy for both species and establishes their sistergroup relationship. Male specimens of *C. sabroskyi* are easily distinguished from those of *C. neotropicus,* however, by the hook-shaped left surstylus. The aedeagal apodeme is larger in *C. neotropicus,* its length equal to combined 5th, 6th, and 7th tergites. Females of *C. sabroskyi* are unique among Neotropical species by having the 8th sternite reduced and partially retracted below sternite 7 (see description above).

Cyamops americus Baptista and Mathis

Cyamops americus Baptista and Mathis, 1994: 14–17.

Specimens Examined.—*COSTA RICA.* Bahía Carrillo National Park (10°10′N, 84°07′W, 500 m), 10 Apr 1985, H. Goulet, L. Masner (1 ♂, 1 ♀; CNC). *GUYANA.* CEIBA (a biological station ca. 40 km S Georgetown, 06°29.9′N, 58°13.1′W), 21 Apr 1995, W. N. Mathis (3 ♂; USNM). *MEXICO. Chiapas.* Bochil/ Yerba Buena (6500 ft, 20 mi N), 24 Jun 1969, W. R. M. Mason (1 ♀; CNC). El Triunfo (49 Km S Jaltenango, 1300–2000 m), 13–15 May 1985, W. N. Mathis (♂ holotype and 33 ♂, 68 ♀; TAU, USNM)

Distribution.—Neotropical: Costa Rica, Guyana, and Mexico (Chiapas).

Remarks.—This species was previously known only from Mesoamerica (Mexico and Costa Rica), and its discovery in Guyana is a significant extention to our knowledge of this species' distribution.

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AMERICAN SPECIES OF THE GENUS *BRACHYUNGUIS* DAS (HOMOPTERA: APHIDIDAE), INCLUDING TWO NEW SPECIES

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Abstract.—Two New World species belonging to the nearly cosmopolitan genus *Brachyunguis* Das are described. ***Brachyunguis bahamondesi*** from Argentina is known by its apterous and alate viviparous females living on *Atriplex lampa* and *Chenopodium sooanum*. ***Brachyunguis bishopi*** from U.S.A. (Idaho and Oregon) lives on *Sarcobatus vermiculatus*. Morphs representing the complete life cycle of the latter species, from the fundatrix to the sexual morphs, have been observed. Both new aphids are compared with *B. bonnevillensis* (Knowlton) and a key is given for the five species of the genus represented on the American continents.

Resumé.—Deux nouvelles espèces américaines du genre *Brachyunguis* Das sont décrites. ***Brachyunguis bahamondesi*** n. sp. existe en Argentine sur *Atriplex lampa* et *Chenopodium sooanum* et est connu par ses formes vivipares aptères et ailées. ***Brachyunguis bishopi,*** trouvé aux USA (Idaho et Oregon), vit sur *Sarcobatus vermiculatus* et son cycle complet a été observé, depuis la fondatrice jusqu'aux formes sexuées. Les deux espèces sont comparées à *B. bonnevillensis* (Knowlton) et une clé permet de séparer les 5 espèces du genre représentées sur le continent américain.

Key Words: *Brachyunguis, Xerophilaphis,* new species, key, Chenopodiaceae, U.S.A., Argentina

Species of the genus *Brachyunguis* Das, 1918 (type species: *B. harmalae* Das, 1918) and its subgenus *Xerophilaphis* Nevsky, 1928 (type species: *X. saxaulica*) are widespread in arid regions of the world, their species colonizing xerophytic plants, notably Chenopodiaceae, Tamaricaceae and Zygophyllaceae.

Three species are known in the New World:

B. (*X.*) *tetrapteralis* (Cockerell, 1902), living on *Atriplex* and *Suaeda* in northwestern Mexico and southwestern USA, possibly as far north as central Utah, but probably not in southern Idaho.

B. bonnevillensis (Knowlton, 1928), living on *Atriplex, Sarcobatus,* and a few other Chenopodiaceae in the western half of the USA and in the state of Durango, Mexico.

B. (*X.*) *blanchardi* Remaudière and Bahamondes, 1987 has been found only on *Allenrolfea* in Argentina (province Mendoza).

Two new species are described here: *Brachyunguis bishopi* n. sp., was found on *Sarcobatus* in Idaho and Oregon by the second author; *Brachyunguis bahamondesi* n. sp., was found on *Atriplex* by L. Bahamondes and on *Chenopodium* by D. Matile Ferrero in Argentina (Mendoza Province).

In the text and tables, the following abbreviations are used:

ant.I, III, IV, V, VI: antennae segments I, III, IV, V, VI;
VIb.: base of antennal segment VI;
p.t.: processus terminalis;
u.r.s.: ultimate rostral segment;
h.t.II: second segment of hind tarsus;
abd.: abdomen;
abd.terg.VIII: abdominal tergite VIII;
siph.: siphunculus;
BL: body length;
b.d.III: basal diameter of ant.III.

Brachyunguis bahamondesi Remaudière and Halbert, New Species

Apterous viviparous female (n = 80).—Insect pale, with only siphunculi, apical 1/8 to 1/6 of tibiae and tarsi black; head, ant.VI, rostral segments III and IV, anal, subgenital and spiracular plates dark; thorax and abd. without pigmentation, including abd.terg.VII and VIII, intersegmental sclerites rarely distinct, often absent; cauda with darkened base and lighter apex.

Frontal profile convex, slightly sinuated; setae on vertex shorter than b.d.III (11–16 μm); clypeus rather broad, expanded to occupy 3/4 to 4/5 of the interantennal space but never exceeding the frontal profile; antennae 6 segmented, 0.43 to 0.65 times BL; ant.III 7 to 10 times longer than its median diameter, antennal setae short (8–11 μm, i.e. 0.5 to 0.7 times b.d.III); p.t. = 1.11 to 1.40 VIb.; antennal segment lengths: ant.III = 0.17 to 0.26 mm, ant.IV = 0.12 to 0.18 mm, ant.V = 0.12 to 0.16 mm, ant.VIb = 0.077 to 0.099, pt = 0.077 to 0.123; BL 2.6–3.5 times length of rostrum, rostrum reaching the third coxae, measuring 0.40 to 0.45 mm; u.r.s. pointed, with straight sides or slightly concave, without significant constriction at the level of the subapical setae, 2.2 to 2.9 times as long as its basal width and 5.4 to 6.0 times its subapical width, 1.08 to 1.24 longer than h.t.II, with 2 accessory setae. Posterior seta on trochanter shorter (0.4 to 0.7 times) than the basal diameter of femur, 1.0 to 1.7 times b.d.III; first tarsal segments with 3,2(3),2 setae; h.t.II = 0.088 to 0.107 mm. Siphunculi cylindrical, 2.7 to 3.7 times as long as their median diameter, nearly always a little shorter than the cauda (0.73 to 1.04 times); cauda longer than its basal width, triangular, without constriction, with 6–8 setae; abd.terg.VIII with 2 setae 25–38 μm long (1.5 to 2.0 times b.d.III); subgenital plate with 2 anterior and 7–11 posterior setae. Marginal tubercles only on pronotum and abd.terg.I and VII. Dorsal abdominal cuticle often slightly reticulated.

Alate viviparous female (n = 38).—Head, thorax, apex of tibiae, tarsi and siphunculi almost black; ant.I, apex of ant.V, ant.VI, coxae, small marginal sclerites on abd.terg.I–IV, cauda, anal, subgenital and spiracular plates more or less darkened, like apical half of femur III.

Ant.III with 3–9 widely flanged secondary rhinaria (3–4: 9% of specimens, 5–7: 77% of specimens and 8–9: 15% of specimens; n = 69); IV with 0–2 rhinaria (0: 65% of specimens, 1: 29% of specimens and 2: 6% of specimens); antennal segment lengths: ant.III = 0.23 to 0.28 mm, ant.IV = 0.15 to 0.19 mm, ant.V = 0.15 to 0.18 mm, ant.VIb = 0.085 to 0.110 mm, p.t. = 0.107 to 0.140 mm. First segment of tarsus with 3,2(3),2 setae.

Type material.—Holotype: apterous viviparous female collected on *Atriplex lampa* Gillies ex Moquin at Guyamallen (Mendoza province, Argentina), 14-XI-1989, (L. Bahamondes, in coll. MNHN 013274). Paratypes: apterous and alate viviparous females found with the holotype; apterae and alatae collected on *Chenopodium sooanum* Aellen at Cachauta, 1300 m (Mendoza, Argentina), 5-XII-1993 (D.

Table 1. Comparison between *Brachyunguis bonnevillensis, B. bishopi,* and *B. bahamondesi.* Extreme values are in parentheses.

	bonnevillensis	*bishopi*	*bahamondesi*
Apterous Viviparous Females			
n	36	33	20
Measurements (in mm)			
BL	(0.96) 1.20–1.80 (2.17)	(1.20) 1.60–2.00 (2.25)	(1.08) 1.30–1.60 (1.72)
u.r.s.	(.085) .096–.110 (.115)	(.096) .110–.130 (.137)	.110–.121
siph.	(.044) .070–.130 (.164)	(.079) .110–.190 (.219)	(.096) .110–.150 (.159)
cauda	(.104) .130–.180 (.214)	(.110) .130–.170 (.203)	(.112) .120–.145 (.150)
Ratios			
p.t./VIb.	(0.53) 0.60–0.95 (1.01)	0.69–0.90 (1.00)	(1.00) 1.10–1.25 (1.36)
u.r.s./ht.II	(0.81) 0.90–1.00 (1.03)	(0.87) 0.92–1.00 (1.11)	1.10–1.25
siph./cauda	(0.42) 0.50–0.75 (0.87)	(0.70) 1.00–1.20 (1.25)	(0.73) 0.84–0.95 (1.04)
siph/ant.III	(0.33) 0.37–0.55 (0.64)	(0.56) 0.60–0.75 (0.89)	(0.50) 0.55–0.70 (0.79)
Length of setae (in μm)			
ant.III	8–14	22–47	8–11
vertex	11–22	35–60	11–16
femur I	11–25	27–55	14–19
abd. terg. VIII	14–27	41–60	25–41
Alate Viviparous Females			
n	29	16	20
Measurements (in mm)			
BL	(1.23) 1.40–1.85 (2.17)	(1.58) 1.70–1.90 (2.02)	1.21–1.64
u.r.s.	(.096) .101–.112	(.104) .110–.123 (.129)	.107–.115 (.123)
siph.	(.055) .065–.115 (.121)	(.088) .105–.135 (.164)	.107–.126 (.145)
cauda	(.099) .120–.160 (.184)	(.134) .140–.160 (.170)	(.088) .107–.130 (.137)
Ratios			
p.t./VIb.	0.59–0.85 (1.00)	0.71–0.95 (1.00)	1.11–1.30 (1.40)
u.r.s./ht.II	(0.82) 0.85–0.95 (1.00)	(0.84) 0.90–1.05	1.08–1.18 (1.24)
siph./cauda	0.49–0.58	(0.58) 0.70–0.85 (1.05)	0.93–1.13
siph/ant.III	0.29–0.40 (0.44)	(0.35) 0.40–0.53	0.44–0.55
Length of setae (in μm)			
ant.III	8–12	14–36	8–16
vertex	14–25	27–55	14–17
femur I	14–22	27–41	11–19
abd.terg.VIII	19–33	38–55	25–38

Matile Ferrero coll.; MNHN 015084). The holotype is preserved in the MNHN. Paratypes are deposited in the authors' collections, in the USNM, and in the BMNH (London).

Etymology.—The species is named after Dr. L. Bahamondes as an acknowledgment for the important aphid material received from him during the last 25 years.

Discussion.—*Brachyunguis bahamondesi* differs from the 2 other American species of *Brachyunguis* s. str. by its black siphunculi, p.t. distinctly longer than VIb. and its ratio u.r.s./h.t.II exceeding 1.05. Like *B. bonnevillensis,* its setae are short (Table 1). In the recent key to the South American Aphidina (Remaudière 1994), the species mentioned as *B.* sp. is *B. bahamondesi.*

Brachyunguis bishopi Remaudière and Halbert, New Species

Fundatrix (n = 4).—Body pale, but with eyes, antennae (except ant.II, basal ½ of ant.III, and sometimes basal ½ of IV, lighter), clypeus, apical segments of rostrum, apices of tibiae, tarsi, cauda, anal plate dark

to black; siphunculi, basal ¾ of tibiae, subgenital and spiracular plates hardly darkened; intersegmental sclerites distinct, slightly pigmented.

Insect rotund, only 1.3–1.4 as long as wide (in moderately flattened slides). Head with the frontal line convex; vertex with long setae (47–50 μm, a little longer than b.d.III); antennae 5 segmented, about ⅓ of BL; ant.III 12-13 times longer than its median diameter, with long and pointed setae (27–41 μm, 1.3–1.9 times b.d.III); p.t. short, only 0.66–0.68 times Vb; antenal segment lengths: ant.III = 0.34 to 0.39 mm, ant.IV = 0.16 to 0.18 mm, ant.Vb = 0.13 to 0.14 mm, p.t. = 0.088 to 0.093 mm. Rostrum not reaching the third coxae, measuring 0.51 to 0.57 mm; u.r.s. subequal to h.t.II (0.90–0.98 times) with 2 accessory setae. Siphunculi short, delicately imbricated, BL 15–21 times length of siphunculi, siphunculi 2.0–2.7 times as long as their median diameter, shorter than the cauda (0.63–0.82 times); cauda triangular, with 8–12 setae; abd.terg.VIII with 4–7 long setae (58–63 μm, about 3 times b.d.III); subgenital plate with 3–5 anterior and 9–17 posterior setae. Branches of the mesothoracal furca joined on a very wide base. Marginal tubercles inconspicuous on the pronotum but evident on the abd.terg.I and VII as well as on most of abd.terg.II to V.

Apterous viviparous female (n = 70).—Body quite pale except apex of ant.V, middle of ant.VI and tarsi slightly darkened.

Frontal profile sinuated with the median part clearly higher than the short antennal tubercles; eyes prominent; clypeus conspicuously bulging although rarely exceeding ⅔ of the interantennal space; setae on vertex long and thin (35–60 μm, 1.7–2.5 times b.d.III); antennae 6 segmented (5 segmented in dwarfish summer specimens), about ½ (0.41–0.55 times) of BL; setae on ant.III 22–47 μm, 1.3 to 2.0 times b.d.III; p.t. = 0.69 to 0.95 (1.00) times VIb.; antennal segment lengths: ant.III = 0.12 to 0.30 mm, ant.IV = 0.08 to 0.23 mm, ant.V = 0.10 to 0.22 mm, ant.VIb = 0.09 to 0.16 mm, p.t. = 0.038 to 0.118; BL 2.9 to 4.3 times rostrum, rostrum almost reaching the hind coxae, measuring 0.38 to 0.54 mm; u.r.s. usually subequal to h.t.II (0.87–1.10), 2.2–2.6 longer than its basal width and 4.0–4.7 its subapical width. Posterior seta on trochanter usually subequal (0.7–1.2) to the basal diameter of the femur, 1.9–2.9 b.d.III; dorsofemoral setae long (25–55 μm, 1.3–2.4 b.d.III); first joint of tarsus with 3,3(2),2 setae; h.t.II = 0.096 to 0.151 mm. Siphunculi cylindrical, hardly imbricated, with subapical constriction and distinct flange, 2.2 to 4.4 longer than their median diameter, varying from 0.70 to 1.25 as long as the cauda; abd.terg.VIII with 4–8 (frequently 5–6) long setae (35–60 μm, 1.7 to 3 times b.d.III); cauda without constriction and often a little longer than its basal width, with 6–9 setae (rarely up to 13); subgenital plate with 3–6 anterior and 9–14 (17) posterior setae. Marginal tubercles on the pronotum and abd.terg.I and VII as well on some, or most, of abd.terg.II–V.

As frequently occurs in aphids evolving in arid climates, a very high seasonal variability is observed between specimens. Dwarfing occurs in hot and dry periods with marked allometric changes in morphology such as reduction of the number of antennal segments and shortening of siphunculi, cauda, and setae. The number of marginal tubercles does not seem affected by this kind of stress, but variability occurs in the number of lateral abdominal tubercles and is not yet understood.

Alate viviparous female (n = 19).—Head and thorax very dark; antennae variably pigmented with ant.I and II dark, ant.III–VI darkened either over their whole length or, at least, on their apical half; legs pale with apex of tibiae and tarsi darkened; femora sometimes dark on apical ½ to ⅔ and the tibiae slightly pigmented; abdomen with marginal sclerites on segments II–IV; siphunculi, cauda, anal, and subgenital plates occasionally darkened.

Antennae 0.5–0.6 times BL, ant.III with 2–9 secondary rhinaria (mostly 4–7) irreg-

ularly distributed on its whole length; ant.IV rarely (1 of 34 observed antennae) with 1 rhinarium; antennal segment lengths: ant.III = 0.23 to 0.31 mm, ant.IV = 0.16 to 0.21 mm, ant.V = 0.16 to 0.21 mm, ant.VIb = 0.121 to 0.148 mm, p.t. = 0.090 to 0.126. Siphunculi shorter than those of the apterae: ratio of siph./cauda usually 0.70-0.86 but extreme values such as 0.58 and 1.05 are observed. Setae a little shorter than in apterae (table 1) but their length more or less corresponds to that of the summer and fall apterous specimens. Marginal tubercles rarely present on the abd.terg.II to V (a single tubercle was observed on these tergites only in ⅓ of the studied specimens).

Oviparous female (n = 14).—Aspect and pigmentation like that of the apterous viviparous female. Dark pea green to grey in life. Antennae 6 segmented (sometimes 5 segmented); antennal segment lengths: ant.III = 0.10 to 0.17 mm, ant.IV = 0.08 to 0.11 mm, ant.V = 0.09 to 0.12, ant.VIb = 0.08 to 0.10 mm, p.t. = 0.076 to 0.096 mm. Tibia III slightly incrassate, with 10–30 circular pseudosensoria (diameter: 5–13 μm). Siphunculi shorter than in the apterous viviparous female (0.05–0.10 mm), 1.3 to 2.2 as long as their median diameter; abd.terg.VIII with 8–12 rather long setae (33–55 μm); cauda with 9-12 setae; subgenital plate covered with approximately 40 setae. Marginal tubercles rarely present on one of abd.terg.II–V.

Apterous male (n = 6).—Head, antennae, genitalia and anal plate strongly pigmented, as is a narrow band on abd.terg.VIII; legs and siphunculi variably darkened. Very dark grey in life.

Antenna 6-segmented, exceeding ⅔ (0.68–0.78 times) of BL; ant.III with 3–11 secondary rhinaria, IV with 3–12, V with 4–11 and VIb. with 2–5; antennal segment lengths: ant.III = 0.18 to 0.24 mm, ant.IV = 0.11 to 0.19 mm, ant.V = 0.12 to 0.16 mm, ant.VIb = 0.098 to 0.115 mm, p.t. = 0.082 to 0.096 mm. Siphunculi short (0.04–0.06 mm), not more than 1.5–1.8 times their median diameter; ratio siph./cauda low: 0.57–0.71; abd.terg.VIII with 4–7 setae. Marginal tubercles irregularly present on a few of abd.terg.I–V: often 0, sometimes 1 to 3.

Type material.—Holotype: apterous viviparous female on *Sarcobatus vermiculatus* (Hook) Torr., Canyon Co., Parma (Idaho, USA), 21-V-1993 (S. Halbert coll., #1452). Paratypes: apterous and alate viviparous females collected with the holotype; fundatrices on the same host, Parma, 21-IV-1991 (S.H. #1554; MNHN 013844); apterous, idem, 23-VIII-1986 (S.H. #660; MNHN 012833); idem, 14-VII-1991 (S.H. #1358; MNHN, 015348); apterous and alate, idem, 5-V-1992 (S.H. #1406; MNHN 015349); idem, 7-VII-1994 (Coll. Peggy Graves and Debra Stansell, S.H. #1517; MNHN 015345); apterous viviparous females, apterous males and oviparous females, idem, 18-X-1994 (S.H. #1550; MNHN 015346); vagrant and trapped alate in Adrian (Oregon), Parma, Burley and Aberdeen (Idaho) from 1986 to 1994. The holotype of *B. bishopi* is preserved at the USNM (Washington, D.C.). Paratypes are deposited in the authors' collections, in the USNM, in the BMNH (London), and in the W.F. Barr Museum at the University of Idaho, Moscow, ID.

Etymology.—The new aphid is named for Guy W. Bishop, Professor Emeritus of the University of Idaho, in honor of his significant contributions to knowledge of Idaho aphids over his 30-year career.

Discussion.—After the first detection of this new species, 8 years elapsed before the discovery of every morph of its life cycle. The aphid is monoecious holocyclic, and its single known host is *Sarcobatus vermiculatus*. The related species *B. bonnevillensis* lives on the same host but also colonizes some other Chenopodiaceae, particularly *Atriplex canescens* (Pursh) Nutt. Both species are represented in the studied area and both colonize terminals of *S. vermiculatus*.

Living specimens differ in color. *Brach-*

yunguis bishopi is dark pea green, whereas *B. bonnevillensis* is paler and has a frosty appearance due to wax much like the leaves of *A. canescens* which seems to be its preferred host. *Brachyunguis bishopi* was attended by ants on every occasion it was observed, whereas *B. bonnevillensis* colonies often occur without ants. Both species are sedentary and appear to rely on camouflage rather than evasive behavior to protect them from predators. The shape, color, and preferred feeding site of *B. bishopi* makes the aphids look very similar to emerging leaves of *S. vermiculatus,* which are fleshy and cyndrical.

In mounted material, *B. bishopi* shows distinctly longer setae than *B. bonnevillensis* (table 3); its siphunculi, in spite of their variability, appear as relatively longer in the apterous viviparous morph, with the ratio siph./ant.III rarely smaller than 0.66 (rarely higher than 0.55 in *B. bonnevillensis*). Winged forms in trap samples can be separated easily by examining lateral abdominal setae on posterior abdominal segments (see key below, couplet 6).

Key to the American Species of *Brachyunguis* s. l.

The key has been established from the following material corresponding to the 3 former species known in the American continents.

Brachyunguis (*Xerophilaphis*) *tetrapteralis:* collected on *Suaeda californica* at La Rumorosa (Baja California del Norte, Mexico), 12-IV-1981 and on *S. suffrutescens* at Guerrero Negro (Baja California del Sur), 15-IV-1981 (G. Remaudière & A. L. Muñoz Viveros, MNHN 06988 and 07000).

B. (*X.*) *blanchardi:* type series from Argentina on *Allenrolfea vaginata* (Remaudière & Bahamondes 1987) and additional material including several alatae from Uspallata (Mendoza, Argentina), 14-XI-1987 (L. Bahamondes, MNHN 011173).

B. bonnevillensis: paratypes on *Sarcobatus vermiculatus* from Milford (Utah, USA), 6-V-1927 (G.F. Knowlton, remounted slides from USNM); specimens on *Atriplex* sp., north of Gomez Palacio (Durango, Mexico), 15-X-1980 (G. Remaudière; MNHN 06504) and on *Atriplex* ?*canescens,* Cerros Bismark, La Ascensión (Chihuahua, Mexico), 15-X-1990 (A.L. Muñoz Viveros, MNHN 014438); various samples from Idaho and Oregon, USA (S. Halbert, P. Graves, and D. Stansell).

1. Clypeus enlarged, hemispherical, nearly filling the space between the antennae and obviously expanded in the frontal profile . . . . . subgenus *Xerophilaphis* 2
– Clypeus less developed, never expanded in the frontal profile . . . . . *Brachyunguis* s. str. 3
2(1). Siphunculi very short (0.04–0.06 mm); p.t. < VIb. (0.5–0.7); USA, Mexico . . . . . *B.* (*X.*) *tetrapteralis*
– Siphunculi longer (0.16–0.21 mm); p.t. = VIb. (0.97–1.11); Argentina . . . . . *B.* (*X.*) *blanchardi*
3(1). Siphunculi black; p.t. ≥ VIb. (1.00–1.40); u.r.s./h.t.II 1.08–1.25; abd.terg.VIII with 2 (rarely 3) setae; Argentina . . . . . *B. bahamondesi,* n. sp.
– Siphunculi pale; p.t. usually ≤ VIb. (0.53–1.01); u.r.s./h.t.II 0.81–1.11; abd.terg.VIII mostly with 4–5 setae 4
4(3). Material mounted on slides 5
– Material in alcohol or living specimens . . . 6
5(4). Marginal tubercles present on one or more abd.terg.II–V, very rarely totally missing on these segments in the apterous viviparous morph; setae long (table 1); siph/cauda = 0.70–1.25 in apterous morph; USA . . . . . *B. bishopi,* n. sp.
– Marginal tubercles absent on abd.terg.II–V; setae short (see table 1); siph/cauda = 0.42–0.82 in apterous morph; USA, Mexico . . . . . *B. bonnevillensis*
6(4) Lateral abdominal setae long; spring specimens with siphunculi more than 2 times as long as their median diameter; in life, color dark pea green . . . . . *B. bishopi*
– Lateral abdominal setae short, hardly visible on abd.terg.VI–VII; siphunculi always less than 2 times as long as their median diameter; in life, color frosty green . . . . . *B. bonnevillensis*

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A NEW *BEPHRATELLOIDES* (HYMENOPTERA: EURYTOMIDAE) FROM SEEDS OF *CYMBOPETALUM* (ANNONACEAE) IN MEXICO

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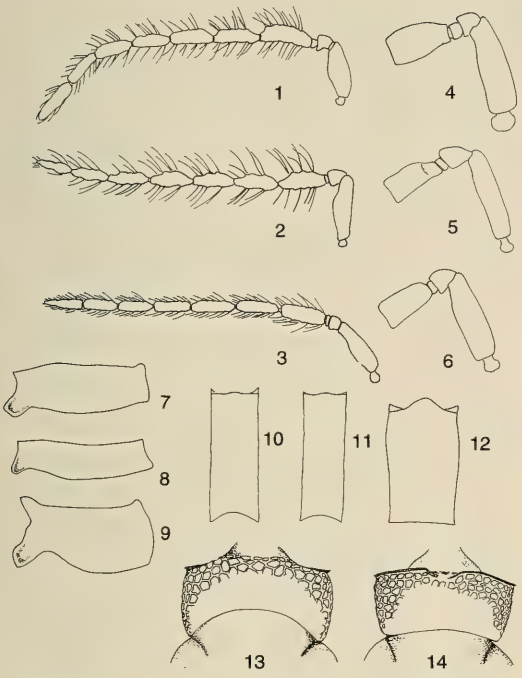
Abstract.—***Bephratelloides ablusus*** Grissell and Foster, new species, is described and illustrated based upon specimens that emerged from seeds of *Cymbopetalum mayanum* (Annonaceae) in southern Mexico. This is the first species of *Bephratelloides* that is associated with a host other than *Annona. Bephratelloides ablusus* is compared with its congeners from which it differs in minor character states. No external morphological characteristics suggest a specialized association with *Cymbopetalum.*

Key Words: Hymenoptera, Eurytomidae, *Bephratelloides ablusus,* new species, *Cymbopetalum mayanum, Annona,* Annonaceae, seed

Species of *Bephratelloides* have previously been reported as seed-feeders in the fruit of *Annona* (Annonaceae) (Grissell and Schauff 1990). Species of *Annona* are cultivated in the tropics under many common names such as cherimoya, custard apple, soursop, guanabana, sugar apple, and atemoya (a commercial cultivar). In this paper we describe the new species *Bephratelloides ablusus,* which feeds in the seeds of a newly discovered host, *Cymbopetalum mayanum* Lundell (Annonaceae), in southern Mexico. Unlike *Annona, Cymbopetalum* is not eaten by humans, but its aril (the partial outer covering of the seed) serves an important function as forage for birds. More than 40 species of birds have been observed to feed on *Cymbopetalum* aril, including 12 species of Nearctic migrants (Foster, unpubl. data). The fruiting period of *Cymbopetalum* coincides with the northward spring migration of these birds, which accounts for about 70% of all bird feeding visits to *Cymbopetalum* trees.

Cymbopetalum, which is closely related to *Annona,* has 27 species ranging from Mexico to Brazil (Fries 1962, Murray 1993). According to Fries (1962), the family Annonaceae contains 35 genera in the Americas, and the genus *Annona* has over a hundred species. Genera related to *Annona* and *Cymbopetalum,* such as *Xylopia, Porcelia,* and *Rollinia,* contain well over 100 additional species. With such diversity at both the generic and specific levels, the probability seems high that other phytophagous species of *Bephratelloides* await discovery and that the host range of these species may be wider than is recognized.

The genus *Bephratelloides* was last revised by Grissell and Schauff (1990), who recognized four valid species: *B. cubensis* (Ashmead), *B. paraguayensis* (Crawford), *B. petiolatus* Grissell and Schauff, and *B. pomorum* (Fabricius). Three of these species are seed-feeders in *Annona,* but the host of *B. petiolatus* is unknown. The taxonomic position of two additional species,



Figs. 1–14. *Bephratelloides* spp. 1–3, Male antenna. 1, *B. ablusus.* 2, *B. petiolatus.* 3, *B. paraguayensis.* 4–6, Female antenna, scape to funicular segment 1. 4, *B. ablusus.* 5, *B. petiolatus.* 6, *B. paraguayensis.* 7–12, Male metasomal petiole (Mt1). 7–9, Lateral view. 10–12, Dorsal view. 7, 10, *B. ablusus.* 8, 11, *B. petiolatus.* 9, 12, *B. paraguayensis.* 13–14, Pronotum, dorsal view. 13, *B. ablusus.* 14, *B. paraguayensis.*

B. limai (Bondar) and *B. melleus* (Westwood), is unclear because their types are lost (Grissell and Schauff 1990). Species of *Bephratelloides* are restricted to the Neotropical Region except for accidental introductions because of commerce associated with *Annona* culture in Florida (Bruner and Acuna 1923) and Hawaii (Heu 1988).

Bephratelloides ablusus Grissell and Foster, New Species

(Figs. 1, 4, 7, 10, 13, 15, 18, 21, 24–26)

Description.—Female length 4.0 to 5.8 mm. Body color predominantly black with orange to yellow markings as follows: antenna including scape, head (except ocellar triangle, occiput, and sometimes area laterad torulus), lateral side of pronotum, scutellum and usually posterior of mesoscutum (may be nearly entirely black with only slight indication of dark-orange color), tegula, apices of femora, tibiae (except apex white), foretarsus, mid- and hind tarsomeres 4 and 5 (1–3 white), metasoma ventrolaterally at least on Mt4 to posterior of metasoma, Mt6–8 may be entirely to only laterally orange; wing veins dark brown with hyaline break between apex of parastigma and base of marginal vein, membrane posterad marginal vein with dark-brown infuscation paralleling vein (Fig. 15; may give vein an enlarged and triangular appearance), wing mostly hyaline with weak infuscation extending from marginal and stigmal veins half-way to posterior margin of wing. Head and mesosoma mostly covered with setigerous punctures, interstices between punctures with conspicuous micropunctation; malar area (Fig. 24) without setigerous punctures (distance between nearest punctures 2 or 3× own diameter), surface shagreened, with polished pit at lower eye margin; metasoma polished. Eye height about 1.3× malar distance (Fig. 18), ocellocular distance about 1.2× post-ocellar distance (Fig. 21), antenna with first funicular segment slightly constricted at base (Fig. 4), all funicular segments longer than wide. Mesoscutum in longest median view about 1.7× length of pronotum and subequal to length of scutellum; anterior margin of pronotum with carina laterally (i.e. along vertical margin) that curves slightly onto dorsal surface but then disappears medially (Figs. 13, 24); scutellum in dorsal view with apex somewhat pointed and without emargination, essentially flat to slightly depressed in profile, scarcely projecting beyond dorsellum (Fig. 25); metanotum perpendicular to plane of scutellum; propodeum (Fig. 26) medially with well-defined, nearly parallel-sided furrow, furrow slightly wider dorsally than ventrally, divided into rectangular sections by transverse carinae and without setae, basolaterad furrow with reticulate to shagreened triangular area abuting setigerous cells, anterodorsolateral edge of furrow with large, polished

bare cell. Forewing (Fig. 15) with postmarginal vein not projecting beyond apex of stigma and about 0.5× length of marginal vein, speculum a horizontal <-shaped area, cubital vein with setae basally, lower surface of costal cell with numerous setae arranged in erratic rows, upper surface of costal cell with complete row of setae along anterior margin and several incomplete rows in apical half of cell. Metasoma about 2× length of mesosoma, about 3× as long as wide (in dorsal view), essentially horizontal, petiole (Mt1) about 3× as broad as long (usually difficult to see), dorsomedially with an upward projecting carina.

Male.—Length 3.4 to 4.8 mm. Similar to female, except more variable in color as follows: body sometimes entirely black except apices of femora, tibiae, tegula, and lower face around clypeus yellowish, or color as for female (most specimens) except fore- and midlegs (including coxae) all yellow to orange, hind coxa partially yellow, ventral half of mesosoma yellow, and Mt2–8 yellow laterally. Antenna (Fig. 1) with elongate, cylindrical funicular segments, setae erect, somewhat aligned in rows separated by distinct bare areas and longer than width of segment; propodeum as for female except sculpture usually less distinct (i.e. carinae effaced) and lateral shagreened triangular area either absent or poorly delimited; metasomal petiole (Mt1) dorsally about 2.5–2.7× as long as wide (Fig. 10) and without apical dorsomedian flange (best seen in profile, Fig. 7; cf. Fig. 9).

Distribution.—Known only from the type locality in southern Mexico (Chiapas).

Host.—*Cymbopetalum mayanum.*

Type material.—Holotype female on point with data: Chajul, Zona Marqués de Comillas, Chiapas, Mexico, 16°06′45″N, 90°55′32″W, P. S. Wenninger, M. S. Foster collectors, elev. 185 m, seeds coll. 12 April, 1993, em. 13 April, ex fruits of *Cymbopetalum* (deposited in Universidad Autónoma de México, Mexico City). Paratypes: 16 females, 14 males with same data as holotype except some seeds collected 13 April with emergence several days later: 8 females, 6 males deposited in U.S. National Museum, Washington, D.C.; three pairs each in the Universidad Autónoma de México, Mexico City and the Centro de Investigaciones Ecológicas del Sureste, San Cristóbal de las Casas, Chiapas; one pair each in The Natural History Museum, London and the Canadian National Collection, Ottawa.

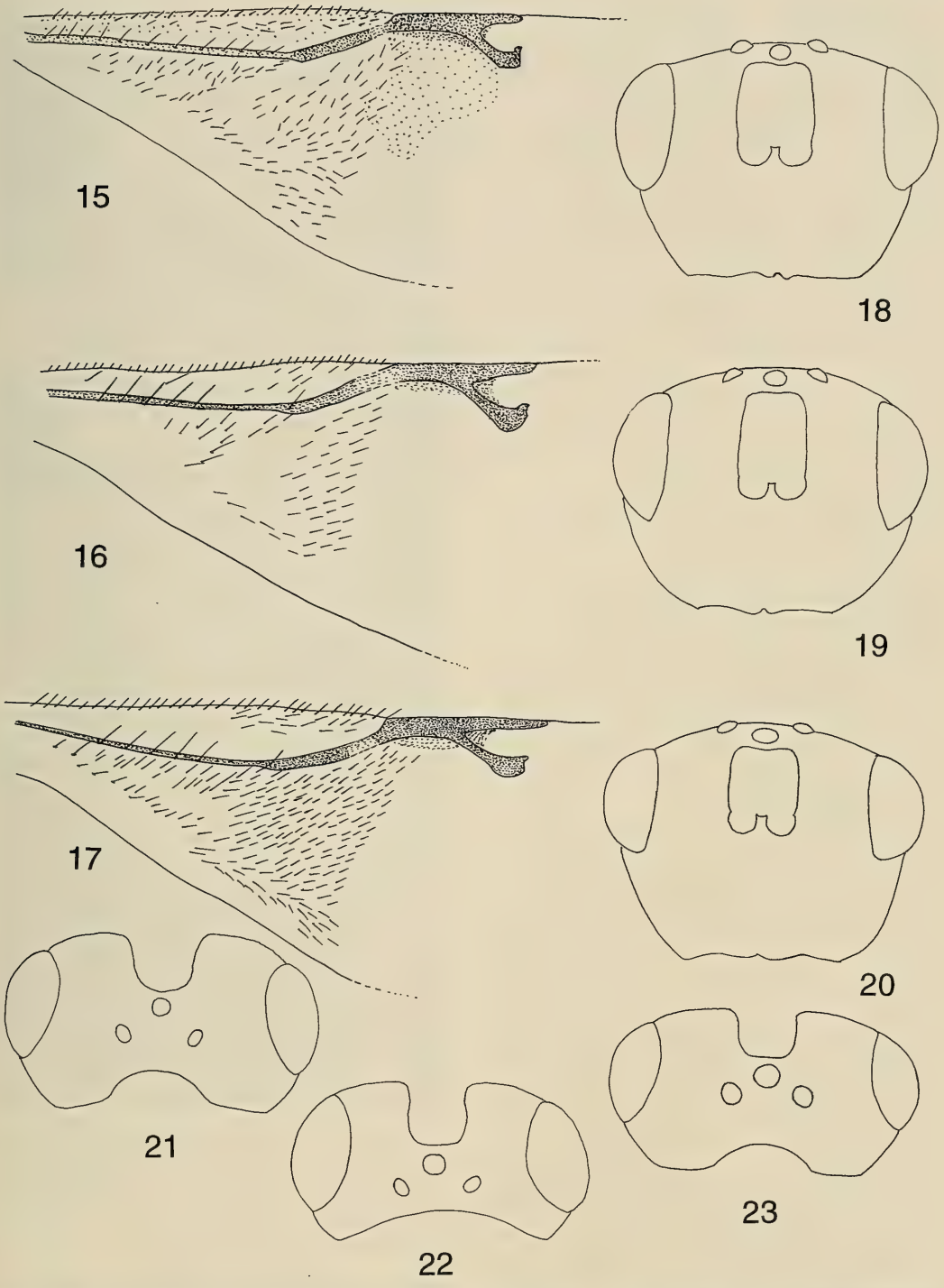
Etymology.—From the Latin "*ablusus*" meaning to "differ" or "be unlike", in reference to the host of this species being different from that of other known species of the genus.

Host plant remarks.—Mature fruits were present at Chajul over a period of about 6 weeks (Foster, unpubl. data). In 1991 and 1993, the main fruiting period ran from about the second week of March to the third week of April. In 1992, however, the fruiting period was shifted about one month later.

Fruits of *C. mayanum* are apocarpic and at Chajul included from 5 to 19 sausage-shaped monocarps (Fig. 27). Monocarps ranged from 4.7 to 7.9 cm in length and from 2.3 to 3.2 cm in diameter. They were largely green when mature, although the exposed abaxial surface was often maroon. When ripe, a monocarp dehisces longitudinally along its abaxial surface to expose two rows of laterally flattened elliptical seeds embedded in cream colored endocarp (Fig. 27). The seeds at Chajul were a shiny, dark purplish black, 11.5 to 18.0 mm long, 6.5 to 9.8 mm wide, and 4.0 to 6.6 mm deep. A bright red-orange aril enveloped the central portion of each seed, leaving the tips and a narrow zone on the distal surface of the seed exposed.

Seeds infested with wasps were easily spotted. Although they generally developed to normal size, they usually were maroon rather than black. Also, the arils enfolding parasitized seeds were tan to yellow-brown.

All parasitized seeds examined contained only a single wasp adult, pupa, or larva. However, one seed with an exit hole also contained a wasp that was about to emerge.

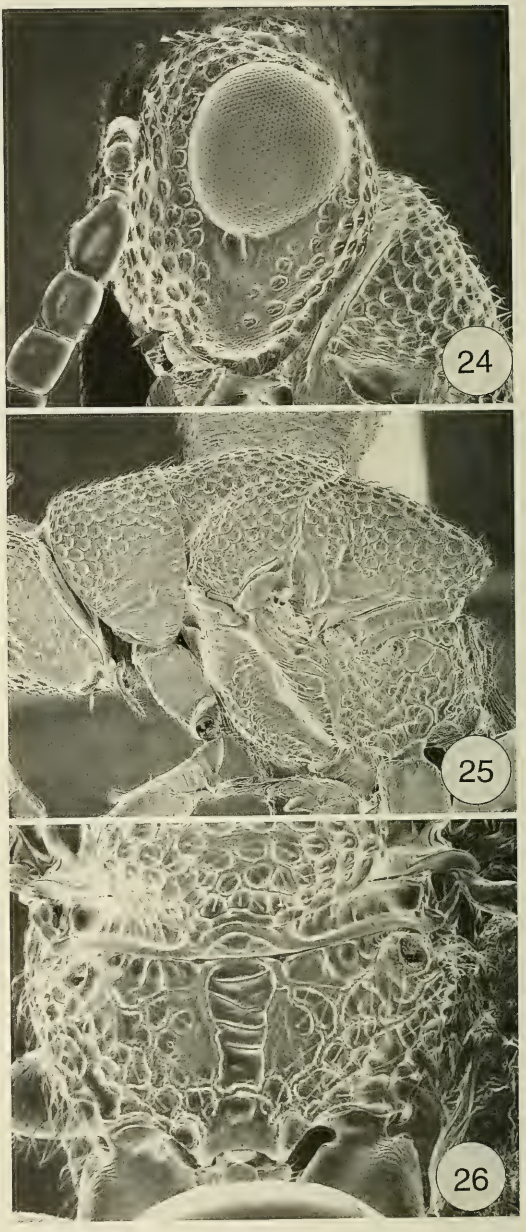


Figs. 15–23. *Bephratelloides* spp. 15–17, Forewing. 15, *B. ablusus.* 16, *B. petiolatus.* 17, *B. paraguayensis.* 18–20, Face, front view. 18, *B. ablusus.* 19, *B. petiolatus.* 20, *B. paraguayensis.* 21–23, Head, dorsal view. 21, *B. ablusus.* 22, *B. petiolatus.* 23, *B. paraguayensis.*

This observation suggests that more than one wasp may develop in some seeds. Wasp exit holes were located at the abaxial ends of seeds, above the level of the aril. Such holes often could be seen in seeds in situ (Fig. 27b). Exit tunnels (Fig. 27a) were followed from the exit holes through the carpel tissue to the surface of the monocarp (Fig. 27c). Such tunnels did not necessarily go directly to the surface, and some were several cm long. Endocarp tissue is soft and probably easily traversed by a wasp. The pericarp is moderately hard. Emergence holes were often visible on the surface of the pericarp and were about 1 mm in diameter on vacated fruit. Wasps often exited the monocarp before it dehisced.

In 1991, the junior author examined 78 monocarps from 3 trees; 51.3% (40) contained one or more seeds with wasps or wasp larvae. In 1993, 53.3% (8) of 15 monocarps examined contained seeds parasitized by wasps. In contrast, none of 25 monocarps examined in 1992 showed evidence of parasitism. Monocarps contained from 6 to 19 seeds (median = 14.2); those with parasites contained from 1 to 5 (median = 1.75) parasitized seeds.

Discussion.—Although *Bephratelloides ablusus* emerged from seeds of a genus of hosts different from that of its known congeners, the species apparently does not reflect any unusual morphological developments as a result of the association. In females the construction of the propodeum (most notably the presence of lateral, shagreened, irregular triangular areas) is somewhat different from that of other species, but males do not show this structure consistently. Based upon a majority of characters, *B. ablusus* appears intermediate between *B. paraguayensis* and *B. petiolatus,* although it shares more characters in common with the latter species than the former. These differences are outlined in the following key couplets, which are intended to replace the key to species of *Bephratelloides* given by Grissell and Schauff (1990). Couplets 1 and 2 also must be simplified as well in order to accommodate the new taxon.



Figs. 24–26. *Bephratelloides ablusus,* scanning electron micrographs. 24, Head, lateral view. 25, Mesosoma, lateral view. 26, Metanotum and propodeum, posterior view.

1. Cells of median area of propodeum with setae and similar to cells on remainder of propodeum . . . . . *B. pomorum* (Fabricius)

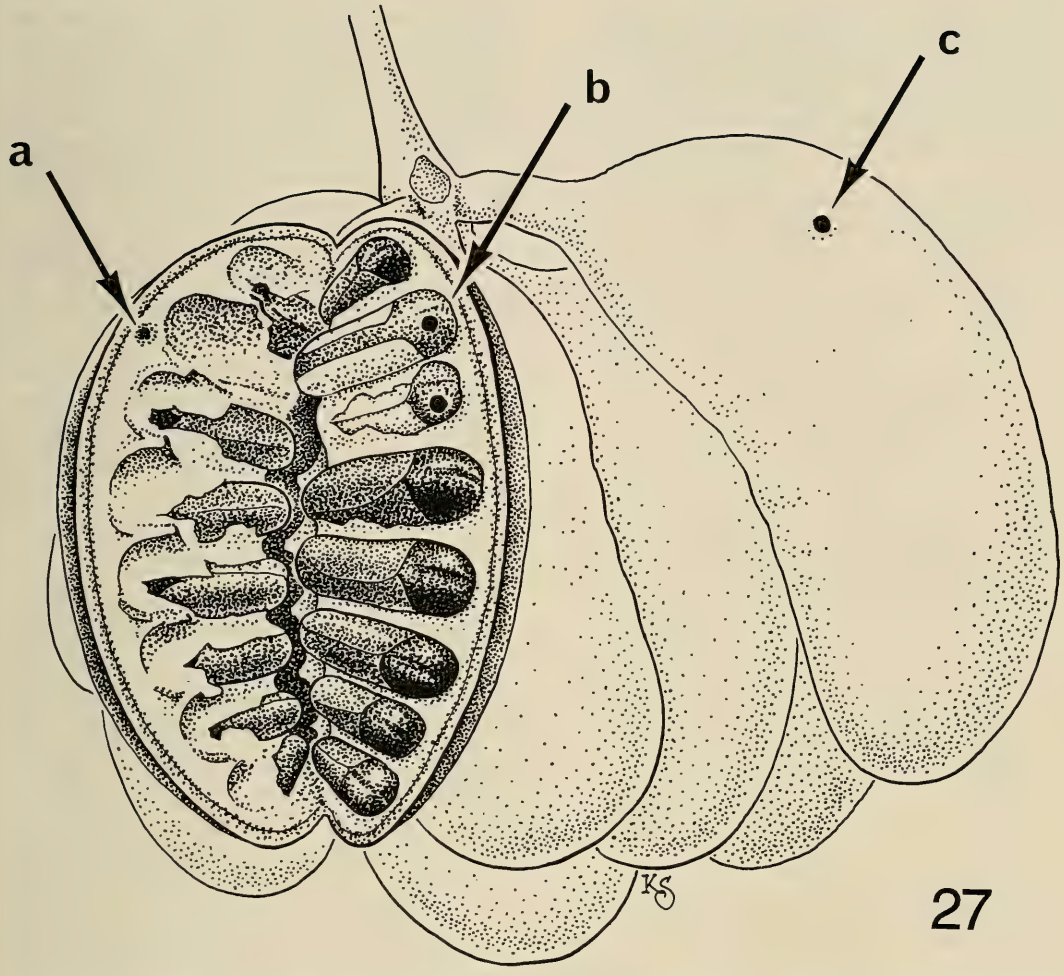


Fig. 27. Apocarp of *Cymbopetalum mayanum* with one dehisced monocarp. Mature, unparasitized seeds are black and enveloped in a bright red-orange aril. Parasitized seeds (b) are maroon and have tan to yellow-brown arils. Wasps exit through a hole (b) at the tip of the seed, and tunnel (a) through the carpel tissue to emerge through a hole (c) at the surface of the monocarp.

– Cells of median area of propodeum without setae, these cells either absent in upper half, transverse (and thus different than lateral cells, Fig. 26), or forming two parallel vertical median rows 2

2. Median area of propodeum lacking distinct carinae in upper half which is flat and glabrous . . . . . *B. cubensis* (Ashmead)

– Median area of propodeum completely carinate, either with distinct transverse carinae (Fig. 26) or with parallel vertical rows 3

3. Both sexes: malar space without setigerous punctures (i.e. widest bare area 2 or 3× puncture diameters in width; Fig. 24); eye height greater than malar distance (Figs. 18, 19); speculum present although possibly small (Figs. 15, 16). Females: first funicular segment constricted at base (Figs. 4, 5); Mt1 (petiole) usually not readily visible and much wider than long (2.5 to 3×). Males: funicular segments with erect setae longer than width of segment (Figs. 1, 2); Mt1 in dorsal view more than 2.5× as long as broad (Figs. 10, 11), in lateral view (Figs. 7, 8) more than 2.5× as long as greatest height, without apical dorsomedian flange. . . . 4

– Both sexes: malar space with nearly contiguous setigerous punctures (i.e. widest bare area 1× or less puncture diameter in width); eye height less than malar distance (Fig. 20); speculum essentially absent (Fig. 17). Females: first funicular segment cylindrical, not constricted at base (Fig. 6); Mt1 about as wide as long.

Males: funicular segments covered with recurved setae that are scarcely as long as width of segment (Fig. 3); Mt1 in dorsal view about 1.5× as long as wide (Fig. 12), in lateral view (Fig. 9) subequal in length to greatest height, with apical dorsomedian flange . . . . . *B. paraguayensis* (Crawford)

4. Both sexes: anterior pronotal carina nearly meeting medially (Fig. 14), separated by distance subequal to or less than post-ocellar distance; post-ocellar distance greater than ocellocular distance (Fig. 22); speculum relatively large (Fig. 16); cubital vein without setae basally; median propodeum with two vertical rows of cells (though these may be irregular and difficult to discern). Females: basal constriction of first funicular segment asymmetrically bent (Fig. 5) . . . . . *B. petiolatus* Grissell and Schauff

– Both sexes: anterior pronotal carina scarcely curving over onto dorsal surface before becoming obsolete (Fig. 13), separated by distance much greater than post-ocellar distance; post-ocellar distance less than ocellocular distance (Fig. 21); speculum relatively small (Fig. 15); cubital vein with setae to base; median propodeum with single transverse cells (Fig. 26). Females: basal constriction of first funicular segment essentially symmetrical (Fig. 4) . . . . . *B. ablusus* Grissell and Foster

In addition to the key characters just given, *B. ablusus* and *petiolatus* appear to differ slightly in wing venation from *B. paraguayensis,* but the character is variable enough to make its use questionable without additional material for study. In both species the postmarginal vein extends barely to the apex of the stigma (Figs. 15, 16) or slightly beyond, whereas in *B. paraguayensis* the postmarginal vein projects distinctly beyond the apex of the stigma (Fig. 17). This difference is reinforced somewhat by the relative lengths of the postmarginal and marginal veins. In *B. ablusus* and *B. petiolatus* the postmarginal vein is about one-half to three-fourths the length of the marginal vein, whereas in *B. paraguayensis* it is three-fourths to subequal in length with the marginal vein. The differences are not entirely distinct but may eventually lend an additional piece of evidence to the understanding of the relationships between *B. ablusus, B. petiolatus,* and *B. paraguayensis.* The only characters that *B. ablusus* and *B. paraguayensis* share are the configuration of the pronotal carinae (as in Fig. 13), and the post-ocellar distance being less than the ocellocular distance (Figs. 21, 23).

Based upon an earlier study of *Bephratelloides* (see comments in Grissell and Schauff 1990), we are confident that *B. ablusus* is conspecific with neither *B. limai* nor *B. melleus.* Although the types of these latter two species cannot be found, their descriptions offer enough detail, especially in color, to exclude them from confusion with *B. ablusus.*

Acknowledgments

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A NEW SPECIES OF *ECTENOPSIS* (*PARANOPSIS*) (DIPTERA: TABANIDAE) FROM NEW ZEALAND AND A KEY TO SPECIES OF THE SUBGENUS *PARANOPSIS*

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Abstract.—***Ectenopsis* (*Paranopsis*) *mackerrasi,*** n. sp., from the North Island of New Zealand is described and illustrated. It is compared to *Ectenopsis lutulensis* (Hutton), the only other known species in this subgenus, and a key to the subgenus *Paranopsis* Mackerras is provided.

Key Words: Diptera, Tabanidae, Pangoniini, *Ectenopsis* (*Paranopsis*), Australasian Region, New Zealand, Key to Species

Mackerras (1955) described *Paranopsis* as a subgenus of *Ectenopsis,* based on *Ectenopsis lutulentus* (Hutton). Only females were available for study. This paper describes a second species in the subgenus *Paranopsis,* supplements the generic definition provided by Mackerras, and includes a key to the species of *Ectenopsis* (*Paranopsis*). The subgenus *Paranopsis* is restricted to New Zealand.

Genus *Ectenopsis* Macquart, subgenus *Paranopsis* Mackerras

Paranopsis Mackerras, 1955: 473, fig. 16. Type-species: *Apatolestes lutulentus* Hutton, 1901. New Zealand.

Eyes bare, without color pattern, those of male with enlarged facets on upper ⅔, distinctly separated from area of smaller facets below. Ocellar tubercle raised and prominent. Front wide, index 2, without frontal callus. Face convex. Third antennal segment with basal 4 flagellomeres widened and partially to mostly fused, apical four flagellomeres clearly defined, apical flagellomere longer than preceding three flagellomeres combined. Maxillary palpi rather flattened, longer than shaft of proboscis, those of male slender, gradually tapered to blunt apex, about ⅓ length of proboscis. Proboscis about equal to head height, stout, with large, soft labella. Hind tibial spurs unusually large and powerful. Cerci as in *Perisilvius* Ferguson. Male genitalia similar to those of other subgenera of *Ectenopsis* (Mackerras 1955).

Ectenopsis (*Paranopsis*) *mackerrasi* Burger, NEW SPECIES

(Figs. 1, 2)

Holotype male.—Length: 11.6 mm. Holoptic, eyes black, without color pattern, upper ⅔ of eyes with facets enlarged, distinctly separated from area of small facets below. Ocellar tubercle large, gray tomentose, distinctly raised above level of eyes, ocelli distinct. Frontal triangle yellowish gray tomentose, bare. Frontoclypeus and genae gray tomentose, white pilose. Beard white. Antennae with scape and pedicel gray tomentose, pilosity yellowish on scape, mixed yellowish and black on pedicel, flagellum reddish brown, basal four flagellomeres enlarged, partially fused, apical four flagellomeres clearly defined, the apical one long and slender, distinctly longer than preceding

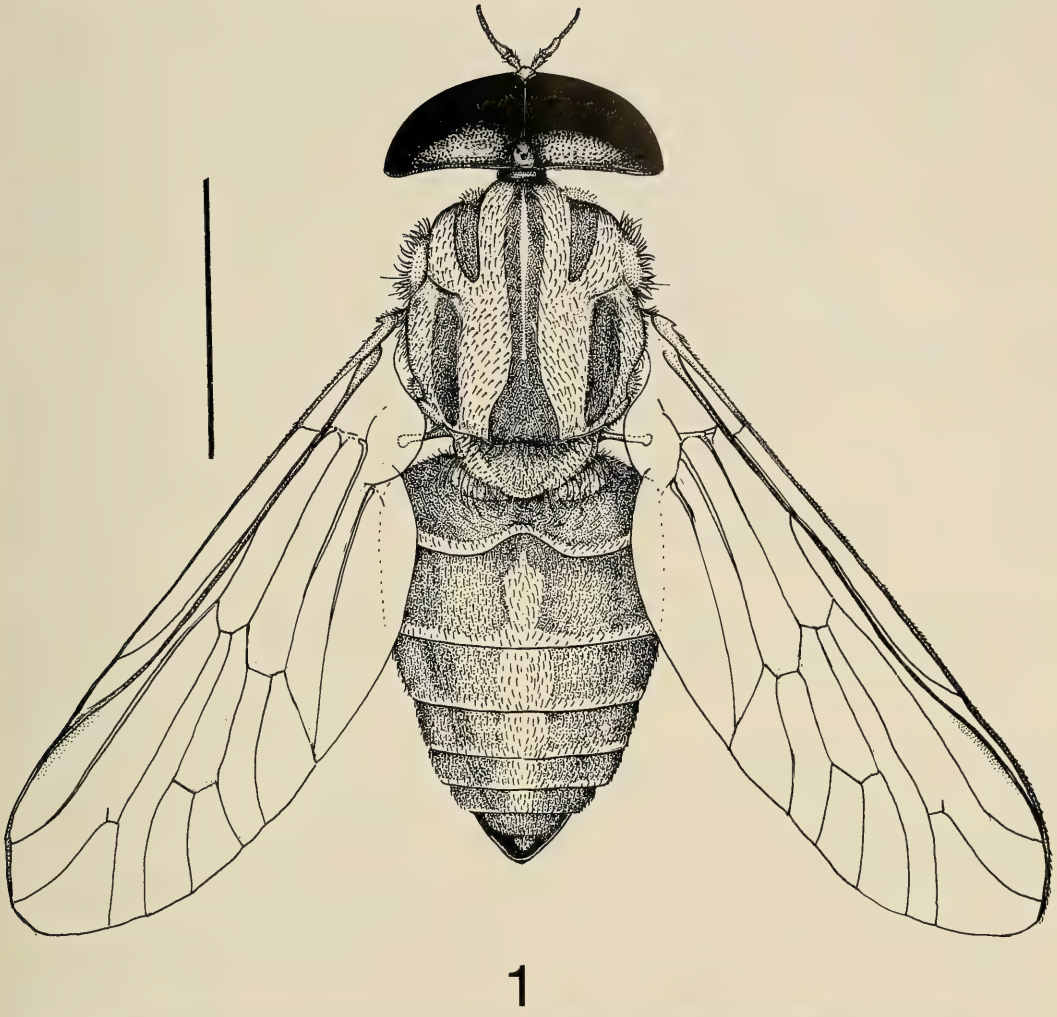

Fig. 1. Holotype male of *Ectenopsis* (*Paranopsis*) *mackerrasi,* dorsal view. Scale bar = 4.0 mm.

three flagellomeres combined. Maxillary palpi gray tomentose, basal palpomere globular, apical palpomere slender, elongate, gradually tapered to blunt apex, about ⅓ length of proboscis, palpi mostly white pilose, with mixed black and white hairs apically. Proboscis gray-brown, labellum large, unsclerotized.

Mesoscutum gray tomentose with a pair of broad submedian and sublateral brown stripes extending its entire length. Scutellum gray tomentose with broad median brown marking, both mesoscutum and scutellum bearing long silky white hairs. Notopleural lobes gray tomentose, white pilose above, black pilose below. Pleuron gray tomentose and white pilose. Legs with coxae gray tomentose, pale pilose, femora brown, darker black-brown subapically, tibiae brown, becoming black-brown apically, hind tibial spurs very large, strongly curved apically, tarsi black-brown. Wings subhyaline with a grayish cast, veins dark brown, sc bare above and below, vein R_4 with spur.

Abdominal tergites gray tomentose with pale yellowish gray posterior margins and distinct brown markings, tergite 1 with broad submedian crescent-shaped mark-

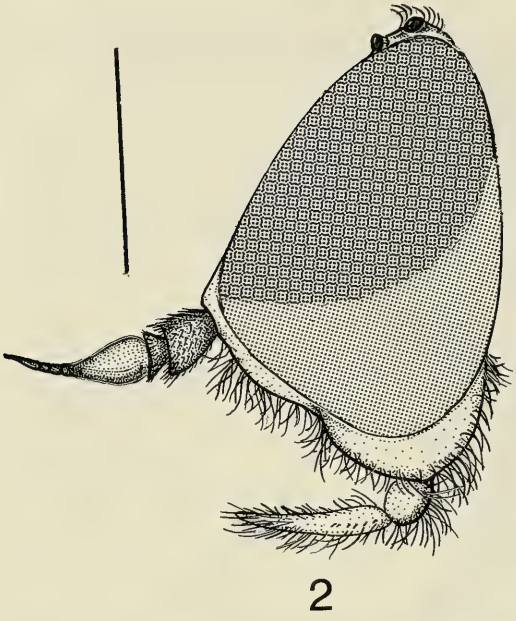

Fig. 2. Head of *Ectenopsis* (*Paranopsis*) *mackerrasi,* holotype male, lateral view. Scale bar = 2.0 mm.

ings, tergites 2–6 with pair of large submedian subquadrate brown patches enclosing a median gray tomentose triangular area, the brown markings largest on tergites 2–3, progressively reduced on posterior segments, tergites predominantly pale pilose. Sternites gray tomentose, white pilose. Ninth tergite (epandrium) large, undivided, shield-shaped. Aedeagus gradually tapered posteriorly, as in *Ectenopsis* (*Perisilvius*). Gonocoxites relatively slender, gradually tapered posteriorly. Gonostyli bifid, outer lobe broadly rounded apically, inner lobe more slender apically and more strongly pointed, as in *Ectenopsis* (*Ectenopsis*).

Holotype male.—NEW ZEALAND: North Isl., Maropiu Distr., Omamari Beach N. of Dargaville, 5. III. 1969, James E. Tobler. In the collection of the California Academy of Sciences, San Francisco, U.S.A.

Etymology.—This species is named for the late Ian M. Mackerras, whose studies on the classification of Tabanidae and the Australasian and Oceanian fauna laid the foundation for the modern classification of Tabanidae and the diversity of Tabanidae of New Guinea, Australia, New Zealand and the Pacific Islands.

Discussion.—*Ectenopsis lutulentus* is known only from the South Island, although Mackerras (1957) cites a questionable record from Taranaki, in the southwestern part of the North Island. *E. mackerrasi* is known only from the northern part of the North Island. Although *E. lutulensis* is known only from female specimens and the species described here is known from a single male specimen, I am confident that they represent distinct species because other described species of *Ectenopsis* for which both sexes are known show little sexual dimorphism.

Key to Species of *Ectenopsis* (*Paranopsis*)

– Mesoscutum and abdomen both without distinct brown markings . . . . . *lutulentus* (Hutton) (♀)
– Mesoscutum bearing distinct brown stripes and abdomen bearing large brown submedian quadrate markings . . . . . *mackerrasi* n. sp. (♂)

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NEW SPECIES IN THE *ANTHONOMUS SALVINI* GROUP (COLEOPTERA: CURCULIONIDAE: ANTHONOMINI)

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Abstract.—Three neotropical anthonomine weevil species, *Anthonomus salvini* Burke (Brazil, Costa Rica, México, Nicaragua, Venezuela) and two new species, ***A. stockwelli*** (Panamá) and ***A. werneri*** (Brazil), are assigned to the *Anthonomus salvini* group. The group and included species are described and a key to the species is presented. The habitus and legs of the three species and the aedeagi of two of the species are illustrated with photographs. The *A. salvini* group is hypothesized to be most closely related to the *A. marmoratus* group.

Key Words: Coleoptera, Curculionoidea, Curculionidae, Anthonomini, *Anthonomus salvini, Anthonomus stockwelli, Anthonomus werneri, Luehea,* Tiliaceae

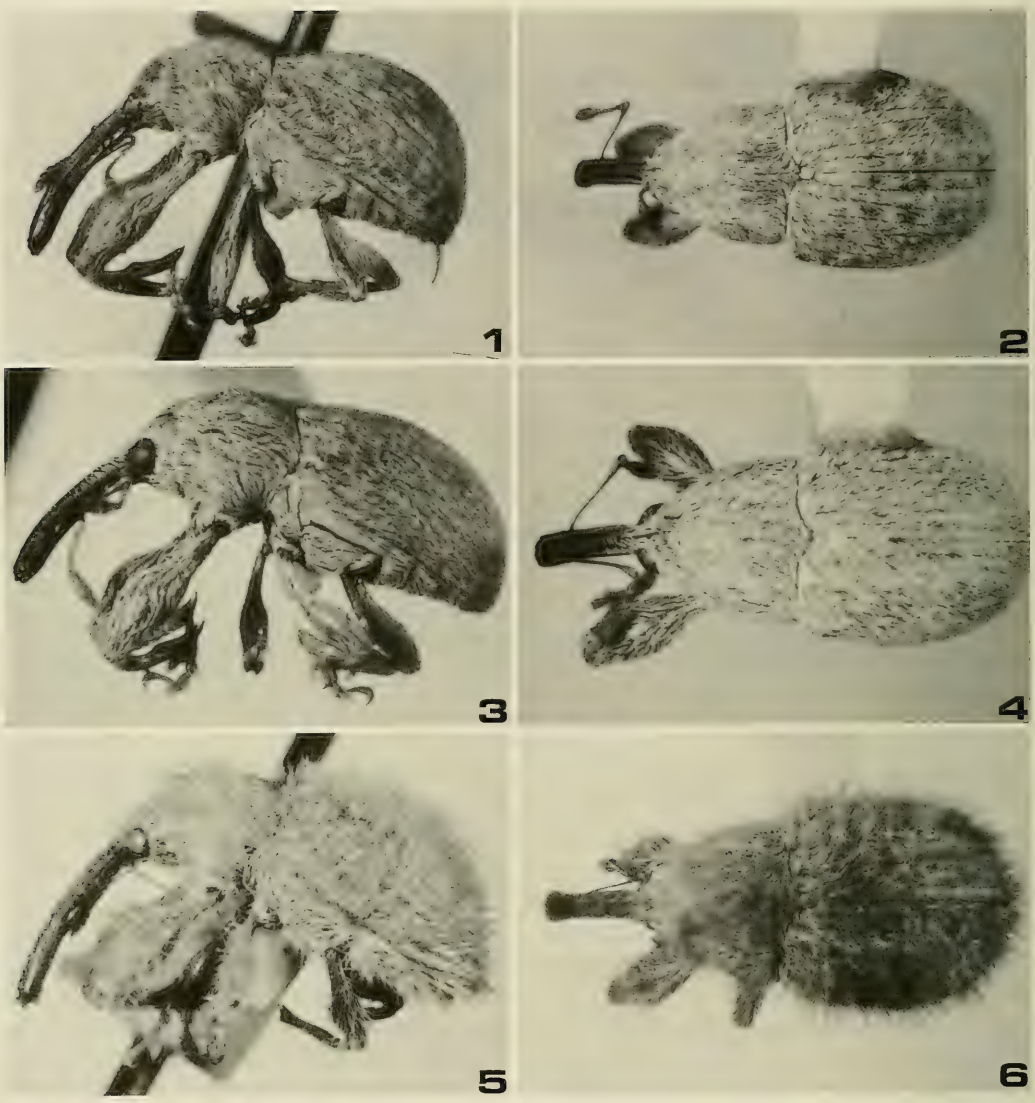
Anthonomus salvini Burke (1979) was described from specimens from Costa Rica reared from flower buds of *Luehea speciosa* Willd. (Tiliaceae). The species was said to closely resemble an undescribed species from Panamá, but these two species were said "... not [to] appear to be especially closely related to any other species of *Anthonomus* and probably [to] form a distinct species group within the genus." The purpose of this paper is to describe that undescribed species, also known to be associated with *Luehea,* along with a third species, previously undescribed, from Brazil. These three species form the *Anthonomus salvini* group.

MATERIALS AND METHODS

Specimens of 84 adult weevils were examined. These are from the collections of the following individuals and institutions (abbreviations identify the collections in the text): Auburn University Entomological Collections, Auburn University, Alabama, USA (AUEM); Collection of C. W. O'Brien, Tallahassee, Florida, USA (CWOB); Collection of H. P. Stockwell, Smithsonian Tropical Research Institute, Panamá (HPSC); Museu de Zoología, Universidade de São Paulo, São Paulo, Brazil (MZSP); Texas A&M University, College Station, Texas, USA (TAMU); National Museum of Natural History, Washington, D.C., USA (USNM). Measurements were made according to criteria described by Clark (1994). Exact label data are cited for types. Separate labels are indicated by brackets ([]), each separate line by a virgule (/).

THE *ANTHONOMUS SALVINI* GROUP

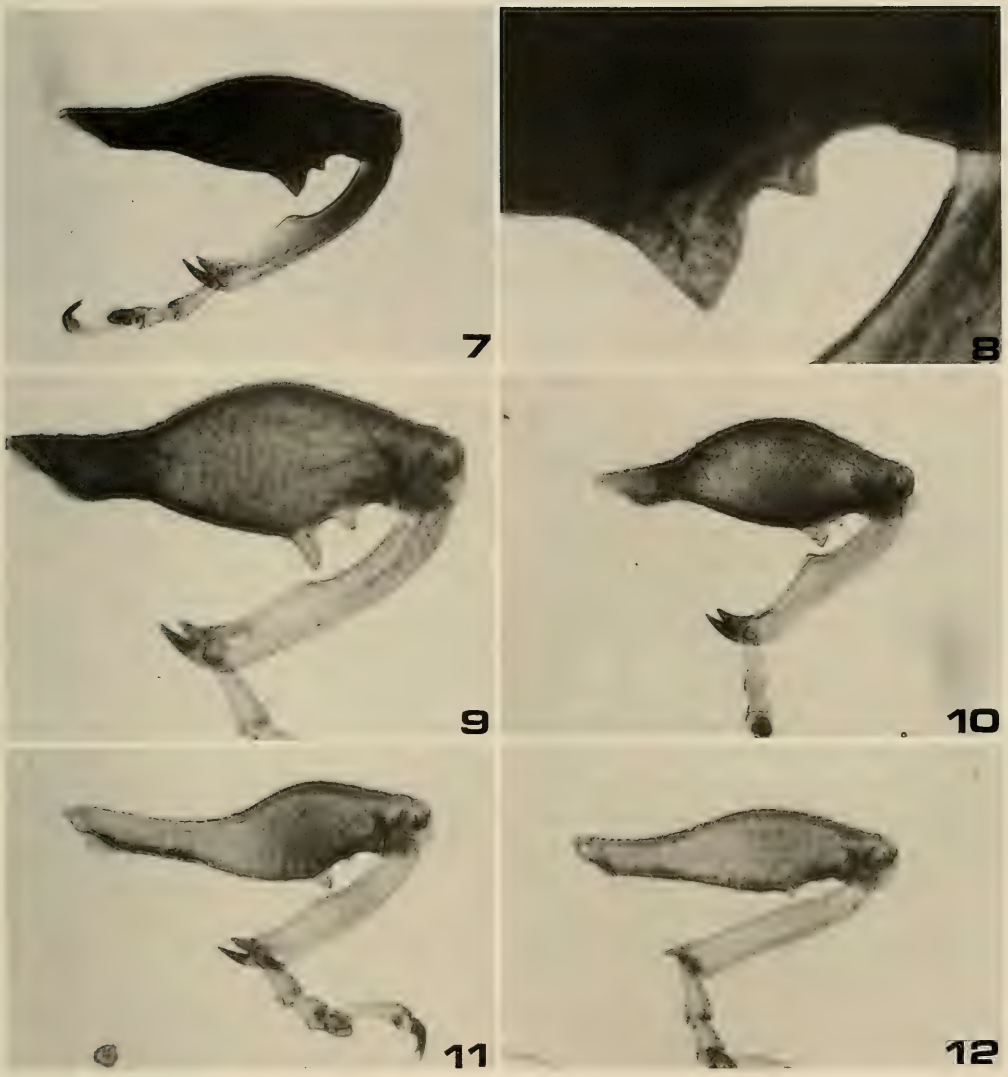
Recognition.—The species in the *A. salvini* group (Figs. 1–6) are middle-sized (length 2.16–4.70 mm) *Anthonomus* with 7-segmented antennal funiculus, ferruginous integument and ochreous to ferrugino-testaceous scales on the head, rostrum, pronotum, elytra and legs. The profemur is strongly inflated and much larger than the meso- and metafemora; it bears a large ventral tooth and a smaller, more anteroventral



Figs 1–6. *Anthonomus salvini* group members, habitus, lateral and dorsal views. 1, 2, *A. salvini,* male, Granada, Nicaragua. 3, 4, *A. stockwelli,* male, holotype. 5, 6, *A. werneri,* female, holotype.

tooth (Figs. 7–10), both on a common base in two of the species (Figs. 7, 8, 10). In addition, the pro- and mesotibiae each have a well-developed ventral prominence, a long, slender, slightly curved apical uncus and a large, stout, preapical spine (Figs. 7, 9–11) and the pronotum has a narrow longitudinal carina in the basal ½.

The species also share the following characters: *Head:* eyes round, slightly, nearly evenly convex, separated by distance ca. 0.8× width of rostrum at base. *Rostrum:* strongly tricarinate. *Prothorax:* pronotum with narrow median carina in basal ½. *Elytra:* interstriae subequal in width and slight convexity. *Legs:* profemur strongly inflated; protibia with well-developed midventral prominence (Figs. 7, 9, 10); pro- and mesotibiae each with a long, slender, slightly curved apical uncus and a large, stout, preapical spine (Figs. 7, 9–11); metatibia straight, with slender apical mucro (Fig. 12).

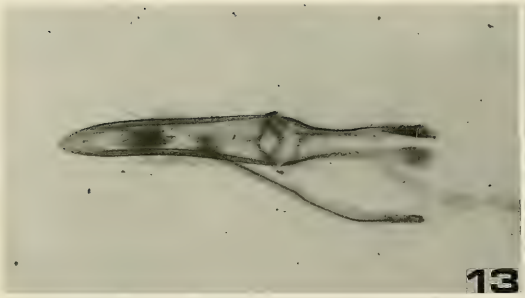


Figs 7–12. *Anthonomus salvini* group members, legs. 7, 8, prothoracic leg, *A. salvini,* female. 9, Prothoracic leg, *A. stockwelli,* female. 10, Prothoracic leg, *A. werneri,* female. 11, Mesothoracic leg, *A. stockwelli,* female. 12, Metathoracic leg, *A. stockwelli,* female.

Plant associations.—Two of the species in the *A. salvini* group are reported from plants in the genus *Luehea* Willd. (Tiliaceae). One of these, *A. salvini,* is represented by specimens reared from flower buds of the host plant (Burke 1979:208). A single Brazilian specimen of *A. salvini* is labelled "Sapindaceae sp."

Distribution.—The species in the *A. salvini* group are known from Brazil, Costa Rica, México, Nicaragua, Panamá and Venezuela.

Relationships.—The *A. salvini* group appears to be most closely related to the *A. marmoratus* group. The greatly inflated profemur and the structure of the profemoral teeth of the species of the *A. salvini* group are similar to those of some of the species in the *A. marmoratus* group (cf. Clark 1992, Figs. 18, 19). Other anthon-



Figs. 13–14. *Anthonomus salvini* group members, aedeagus. 13, *A. salvini,* Grenada, Nicaragua. 14, *A. stockwelli,* holotype.

omines also have similar teeth, however. More interesting is the similarity in armature of the apices of the pro- and mesotibiae. The pro- and mesotibiae of some members of the *A. marmoratus* group, like the species in the *A. salvini* group, have unusually large (for anthonomines) apical unci. More distinctive are the large ventral, preapical spines that characterize some of the species in the *A. marmoratus* group and the similar but even larger spines in the *A. salvini* group (cf. Figs. 7, 9–11, and Clark 1992, Figs. 18–20). Strictly speaking, these similarities indicate that the *A. salvini* group is sister to only a subgroup of the *A. marmoratus* group. This relationship is called into question, however, by the fact that the development of the preapical tooth exhibits a more marked sexual dimorphism in the *A. marmoratus* group (Clark 1992). The species in the *A. salvini* group do not have fascicles of broad, rounded scales around the elytral strial punctures like those in members of the *A. marmoratus* group. Nor do the species in the *A. marmoratus* group have a pronotal carina. Known hosts of members of the *A. marmoratus* group are members of the plant family Fabaceae (Clark 1992).

Key to Species in the *Anthonomus salvini* Group

1. Body with admixture of long, slender, attenuate, ferrugino-testaceous, recumbent scales and similar but slightly longer, suberect scales that coalesce into loose tufts on prothorax and elytra (Figs. 5, 6) . . . . . *A. werneri,* n. sp.
– Body with uniform vestiture of slender, ochreous, recumbent scales, without suberect scales (Figs. 1–4) 2
2. Profemur with a large, broadly triangular ventral tooth and a smaller, more distal ventral tooth sharing a common base (Figs. 7, 8); elytra strongly convex (Fig. 1); aedeagus narrowly rounded at apex (Fig. 13) . . . . . *A. salvini* Burke
– Profemur with a long, slender ventral tooth and a smaller, widely separated, more distal ventral tooth that does not share a common base (Fig. 9); elytra less strongly convex (Fig. 3); aedeagus more broadly rounded at apex (Fig. 14) . . . . . *A. stockwelli,* n. sp.

Anthonomus salvini Burke
(Figs. 1, 2, 7, 8, 13)

Anthonomus salvini Burke 1979:206, 208. Holotype (male). COSTA RICA. Guanacaste: [Santa Rosa National Park/ Guanacaste Prov., COSTA RICA. D. H. Janzen 12 Dec/ 1978–10 Jan 1979.] [ex flower buds/ *Luehea/ speciosa*] [HOLOTYPE/ Anthonomus/ salvini/ Burke] (USNM).

Recognition characters.—Burke (1979: 206, 208) provided a detailed description of *A. salvini,* asserting that the species "... may be easily recognized by its robust form, uniformly distributed pubescence, median carina on the pronotum and greatly enlarged profemur with the two teeth distinctly separated." The species is distin-

guished from the other members of the *A. salvini* group by the following combination of characters: Body with uniform vestiture of slender, ochreous, recumbent scales, without suberect scales (Figs. 1–4); profemur with a large, broadly triangular ventral tooth and a smaller, more distal ventral tooth sharing a common base (Figs. 7, 8); elytra strongly convex (Fig. 1); aedeagus narrowly rounded at apex (Fig. 13)

Distribution.—In addition to 10 specimens from Santa Rosa National Park, Guanacaste Province, Costa Rica, including one labelled "PARATYPE" (TAMU), 52 specimens of *A. salvini* from the following localities were examined. Brazil. Goiás: Jataí (1 MZSP). Mato Grosso: Sinop (1 CWOB). Santa Catarina: Nova Teutônia (1 ELSC, 1 MZSP). São Paulo: Piracicaba (37 AUEM). México. Yucatán: 28 km. N Becanchen (1 CWOB). Nicaragua. Granada: Granada (8 TAMU). Rivas: 10 km. S Sapoa (1 CWOB). Venezuela. Anzoátegui: 18 km. E Periaguan (1 CWOB).

Plant associations.—Literature and label data indicate that *A. salvini* is associated with the following plants:

Sapindaceae
- sp. (Nova Teutônia, Santa Catarina, Brazil)

Tiliaceae
- sp. (Granada, Granada, Nicaragua)
- *Luehea divaricata* Mart. (Piracicaba, São Paulo, Brazil, reared from flower buds [Geraldo Papa, *in lit.*])
- *Luehea speciosa* Willd. (Santa Rosa National Park, Guanacaste, Costa Rica, reared from flower buds [Burke 1979:208])

Anthonomus stockwelli Clark, New Species
(Figs. 3, 4, 9, 11, 12, 14)

Type series.—Holotype (male). PANAMÁ: Panamá [PANAMÁ: Pma. Prov./ 9 km. SE Bayano Bridge/ 9°10′N, 78°46′W/ 8 Sept '74 H. Stockwell] (USNM). Paratypes (18). PANAMÁ: Bocas del Toro [PANAMA, Bocas del/ Toro, Miramar, sea/ level, 82°15′W, 9°N/ 30 Mar. 1979 H. Wolda] [Anthonomus/ # 7] (1 female CWOB). PANAMÁ: Panamá [PANAMÁ: Pma. Prov./ 9 km. SE Bayano Bridge/ 9°10′N, 78°46′W/ 8 Sept '74 H. Stockwell] (3 males, 1 female HPSC); [Panama: Canal Zone/ Albrook Forest Site/ Fort Clayton] [Lot No. 167/ Jan. 30/31, 1968/ R. Hutton/ Black light trap] [University/ Arkansas/ Collection] (4 females CWOB); [Panama: Canal Zone/ Albrook Forest Site/ Fort Clayton] [Lot No. 168/ Jan. 30/31, 1968/ R. Hutton/ Black light trap] [University/ Arkansas/ Collection] (1 male, 2 females CWOB); [Panama: Canal Zone/ Albrook Forest Site/ Fort Clayton] [Lot No. 171/ Jan. 15/16, 1968/ R. Hutton/ Black light trap] [University/ Arkansas/ Collection] (1 male CWOB); [*PANAMÁ:* ZONA DEL CANAL;/ Pipeline Road, 7/ km NW of Gamboa./ Lubin 24 Oct 1975] [Canopy Sample/ Luehea seemannii] (1 male HPSC); [PANAMA, Canal/ Zone, Margarita/ May 30, 1957/ at light] (1 male TAMU); [Panamá C. Z./ Margarita, 4 km NE/ 4 May '75/ H. Stockwell] (1 female HPSC); [PANAMÁ: C. Z./ 5 mi. NW Gamboa/ 24 Oct. '75/ H. P. Stockwell] [Malathion/ Canopy fog] (2 females HPSC).

Recognition characters.—Most, if not all of the specimens in the type series of *A. stockwelli* are the ones Burke (1979:208) referred to as representing "... an undescribed species from Panamá which differ ... [from *A. salvini*] by their smaller size (2.5–3.0 mm, av. 2.7 mm, n = 5), the largest profemoral tooth being broadly triangular, and the two profemoral teeth being more widely separated."

Unfortunately, this statement attributes the "broadly triangular" profemoral tooth to the undescribed species instead of to *A. salvini* when in fact, it is *A. salvini* that has the largest profemoral tooth broadly triangular (Figs. 7, 8), as the description of the species states. The larger profemoral tooth

of the new species is much more slender (Fig. 9). Furthermore, although the two profemoral teeth of *A. salvini* were also described as "distinctly separated," the smaller tooth of *A. salvini* could as well be considered to be a separate prominence that shares a common base with the larger tooth (Figs. 7, 8). In the new species, by contrast, the smaller of the two profemoral teeth is actually separated from the larger one, and the two do not share a common base (Fig. 9).

The new species also differs from *A. salvini* by the shorter, stouter, less strongly curved rostrum (cf. Figs. 1, 3), the less strongly convex elytra (cf. Figs. 1. 3), and by the broader aedeagus with the more bluntly rounded apex (cf. Figs. 13, 14).

Male (Figs. 1, 2).—*Length:* 2.16–2.88 mm (mean = 2.50, n = 8). *Width:* 1.16–1.36 mm (mean = 1.30, n = 8). *Rostrum:* length 1.20–1.36 (mean = 1.27, n = 8) × pronotal length; straight basally, slightly curved apically; apical length of apical portion 31–37% (mean = 35%, n = 8) of total rostral length. *Prothorax:* with long, slender, slightly attenuate, uniformly recumbent, ochreous scales. *Elytra:* interstria 3 widened and slightly elevated at extreme base; interstriae with uniform vestiture of long, slender scales like those on pronotum. *Abdomen:* sternum 5 slightly shorter than sternum 4. *Legs* (cf. Figs. 9, 11, 12): with long, slender, uniformly recumbent scales; profemur ca. 1.5× wider than metafemur, with a long, slender ventral tooth and a shorter, slightly more slender, entirely separate, more distal tooth; meso- and metafemora each with a short, conical, ventral tooth and a minute, more distal tooth, metafemoral teeth; mesotibia with slight midventral prominence. *Genitalia* (Fig. 14): aedeagus slightly, broadly constricted medially, bluntly rounded apically; tegmen with long dorsal parameres.

Female.—*Length:* 2.20-2.88 mm (mean = 2.58, n = 10). *Width:* 1.16–2.88 mm (mean = 1.50, n = 10). *Rostrum:* slightly longer and more slender than in male, evenly curved from base to tip; length 1.28–1.59 (mean = 1.43, n = 10) × pronotal length; length of apical portion 30–43% (mean = 38%, n = 10) of total rostral length. *Legs* (Figs. 9, 11, 12): protibial and mesotibial unci and preapical spines slightly larger, metatibial mucro smaller than male.

Distribution.—*Anthonomus stockwelli* is known only from the type series from Panamá.

Plant associations.—Label data indicate that *A. stockwelli* is associated with the following:

Tiliaceae

Luehea seemannii Tr. & Pl. (7 km NW of Gamboa, Panamá, Panamá)

Etymology.—*Anthonomus stockwelli* is named after the collector of many of the specimens in the type series, Dr. Henry P. Stockwell of Ancon, Panamá.

Anthonomus werneri Clark, New Species
(Figs. 5, 6, 10)

Type series.—Holotype (female). BRAZIL: São Paulo: [Faz. Pau d'Alho/ Itú, SP, Brasil/ II.1963 F. Werner/ U. Martins col.] [PHOTO] (MZSP). Paratypes (2). BRAZIL. São Paulo: 1 female [Barueri/ SP, Brazil/ 8.XI.196/ K. Lenko col.] (MZSP); 1 female [Faz. Pau d'Alho/ Itu, SP/ 1–5.XI.1961/ U. R. Martins col.] (MZSP).

Recognition characters.—*Anthonomus werneri* is distinguished from the other members of the *A. salvini* group and from all other known anthonomines by the admixture of long, slender, attenuate, ferruginino-testaceous, recumbent scales and similar but slightly longer, suberect scales that coalesce into loose tufts on the prothorax and elytra (Figs. 5, 6). It also differs from *A. salvini* and *A. stockwelli* by having the extreme base of elytral interstria 3 slightly widened but not elevated, and from *A. stockwelli* by the broadly triangular profemoral tooth and a smaller, more distal tooth on a common base (Fig. 10) as in *A. salvini* (cf. Figs. 7, 8).

Male.—Unknown.

Female (Figs. 5, 6).—*Length:* 4.08–4.40 mm (mean = 4.20, n = 3). *Width:* 1.10–1.16 mm (mean = 1.13, n = 3). *Rostrum:* length 1.28–1.59 (mean = 1.43, n = 3) × pronotal length; slightly, evenly curved; length of apical portion 44–53% (mean = 47%, n = 3) of total rostral length. *Prothorax:* with admixture of long, slender, attenuate, ferrugino-testaceous, recumbent scales and with similar but slightly longer, suberect scales that coalesce into loose tufts throughout. *Elytra:* interstria 3 slightly widened, but not elevated at extreme base; interstriae with long, slender, recumbent ferrugino-testaceous scales and with longer, suberect scales that form loose tufts like those on pronotum. *Abdomen:* sternum 5 slightly longer than sternum 4. *Legs:* with admixture of recumbent and suberect scales; profemur ca. 1.9× wider than metafemur, with a large, broadly triangular tooth and a smaller, conical outer tooth on a common base (Fig. 10); mesofemur with a single, conical ventral tooth; metafemur unarmed; mesotibia with midventral prominence bluntly rounded.

Distribution.—*Anthonomus werneri* is known only from the type series from Brazil.

Plant associations.—Unknown.

Etymology.—*Anthonomus werneri* is named after one of the collectors of the holotype, the late Floyd G. Werner.

Acknowledgments

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AULACIDAE (HYMENOPTERA) IN THE MID-ATLANTIC STATES, WITH A KEY TO SPECIES OF EASTERN NORTH AMERICA

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Abstract.—Sixteen species of Aulacidae occur in eastern North America, 15 of which are found in the mid-Atlantic region, six species of *Aulacus,* including ***A. schiffi,*** n. sp., from Maryland, and nine species of *Pristaulacus.* Known hosts are wood-boring Coleoptera and Hymenoptera. A key is given for the species of eastern North America, and seasonal flight activity, distributions, and hosts are presented for each species occurring in the mid-Atlantic states. This study is based on 790 specimens of 13 species collected at ten sites in Maryland, Virginia, and West Virginia.

Key Words: *Aulacus, Pristaulacus,* parasitoids, Xiphydriidae, Buprestidae, Cerambycidae

Species of Aulacidae are parasitoids of wood-boring insects. Hosts are not certain for many, but some *Aulacus* are associated with *Xiphydria* spp. (Hymenoptera: Xiphydriidae), and some *Aulacus* and most *Pristaulacus* are associated with wood boring Coleoptera, especially Buprestidae and Cerambycidae. Most are more commonly reared than collected in the field. From 13 years of Malaise trapping at various sites in Maryland, Virginia, and West Virginia, I have collected 790 specimens of 13 of the 15 species that occur in the mid-Atlantic states and of the 16 species that occur in eastern North America. This includes two new species, the previously described *A. impolitus* Smith (1991) and *A. schiffi* described below. Thirty aulacid species are known in North America north of Mexico, 9 of *Aulacus* and 21 of *Pristaulacus.* Here I give a key to eastern North American species, present seasonal flight activity based on my collections in the mid-Atlantic states, and review distributions and hosts for each species.

Materials and Methods

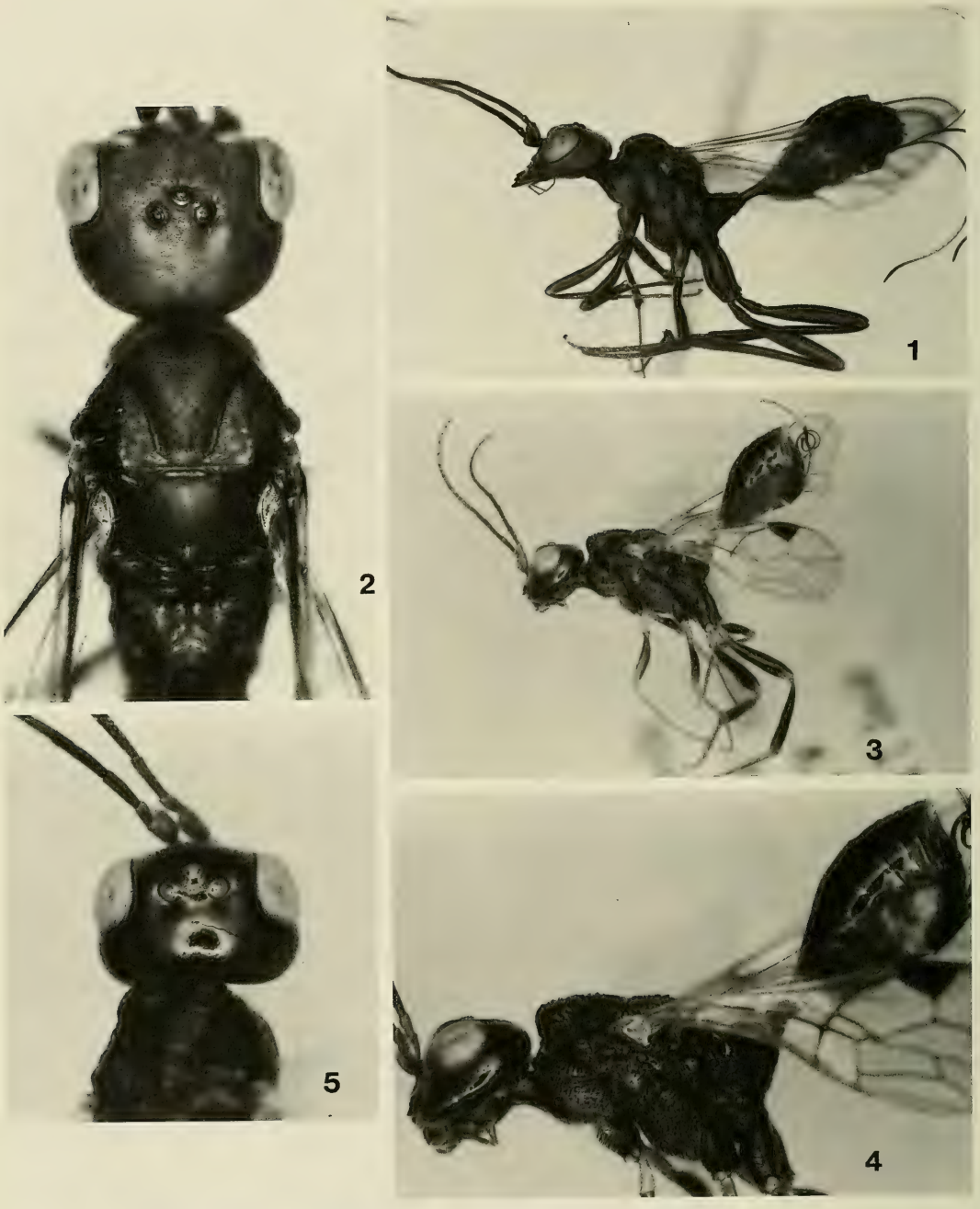
Most collections were made by Townes-style Malaise traps (Townes 1972), using 95% ethyl alcohol as a killing agent; for those in Allegany Co., Maryland, and Randolph Co., West Virginia, potassium cyanide was used as a killing agent; and those in Randolph Co. were Cornell-style Malaise traps. Traps were in continuous operation from March or April through October or November, depending on the site, and usually serviced every ten days to two weeks or sometimes longer intervals depending on the weather and time of season. Trapping was at ten collecting sites from the coastal plain to the Appalachians. The localities, dates of operation, and number of traps used per year are as follows: MARYLAND: Allegany Co., Green Ridge State Park, 5 mi E Flintstone (1991–1993; 6 traps); Garrett Co., Finzel Swamp, 1 km S Finzel (1992–1993, 2 traps); Prince George's Co., Beltsville Agricultural Research Center, 3–6 mi E Beltsville (1991–1993, 3 or 4 traps).

VIRGINIA: Essex Co., 1 mi SE Dunnsville (1991–1994, 12–16 traps); Clarke Co., University of Virginia Blandy Experimental Farm and State Arboretum of Virginia, 2 mi S Boyce (1990–1994, 5–11 traps); Louisa Co., 4 mi S Cuckoo (1987–1989, 4–12 traps); Fairfax Co., near Annandale (1982–1994, 1 trap [backyard]). WEST VIRGINIA: Tucker Co., Fernow Experimental Forest, 3 mi S Parsons (1991–1993, 20 traps); Hardy Co., 3 mi NW Mathias (1994, 2 traps); Randolph Co., south of Dolly Sods Picnic Area (1993, 3 traps). In the specimens examined sections, reference to these sites is by state and county, and years are given for inclusive dates only if one or several specimens were captured.

For references to original descriptions and synonymies, see Townes (1950) and Carlson (1979). The key is adapted from Townes (1950). Distribution records are from Townes (1950), from specimens in the National Museum of Natural History, or from collections I have examined (see acknowledgments). Information in the specimens examined sections are from my collections. Length measurements exclude the antennae and ovipositor. All figures are of females except for *Pristaulacus violaceus*. Specimens from my collections are in the National Museum of Natural History, Washington, D.C.

Key to Genera and Species

1. Tarsal claws apparently simple, each with a minute subapical tooth near base, difficult to see; occipital carina absent; small species, length usually less than 7 mm (except *A. impolitus*); wings usually uniformly hyaline or slightly darkish (*Aulacus*) 2
– Tarsal claws with two or more distinct subapical teeth; occipital carina present as a narrow rim or broad upturned flange; usually larger species, length more than 8 mm; wings various but commonly with dark spots and sometimes uniformly black or black with a yellow cross band (*Pristaulacus*) 7
2. Frons without wrinkles; back of head without wrinkles in position of occipital carina; hindcoxa of female without a projecting ventral lobe; probably parasites of Coleoptera 3
– Frons with reticulate ridges or with transverse wrinkles anteriorly (Figs. 7, 9, 12, 15); back of head with concentric wrinkles in position of occipital carina; hindcoxa of female with a ventral lobe projecting well beyond trochanter socket (as in Fig. 6); parasites of *Xiphydria* . 4
3. Head and mesosoma finely granular, dull; entirely reddish brown; ovipositor sheath about 0.8× forewing length; length, 7.5–9.0 mm (Figs. 1, 2) . . . . . *A. impolitus* Smith
– Head smooth and shining, mesosoma shiny with reticulations or ridges; almost entirely black; ovipositor sheath about 0.5× forewing length; length, 6 mm (Figs. 3–5) . . . . . *A. schiffi*, n. sp.
4. Reticulate or transverse wrinkling of frons coarse and extending almost to middle ocellus (Fig. 7); sides of pronotum with some coarse rugosities in addition to finer rugosities and some punctation; apex of metasoma usually black; mesosoma black, sometimes part of pronotum dark orange; head usually black . . . . . *A. pallipes* Cresson
– Wrinkling of frons mostly transverse, fine and confined mostly to its anterior portion, sometimes reticulate but rarely extending close to middle ocellus (Figs. 9, 12, 15); sides of pronotum punctate or shining and partly finely rugose, without coarse rugosities; metasoma pale, rarely blackish at apex; mesosoma orange to reddish or black; head usually pale, sometimes blackish dorsally 5
5. Apical process of female hindcoxa (as in Fig. 6) more than 1.4× as long as wide); mesosoma black, sometimes pronotum partly orange; wrinkles on anterior part of frons irregular, more or less transverse, surface between wrinkles more punctate (Fig. 9) (ovipositor sheath about 0.9× forewing length; side of mesosoma dull, granular between sculpture . . . . . *A. digitalis* Townes
– Apical process of female hindcoxa less than 1.4× as long as wide; mesosoma usually pale; transverse wrinkles on anterior part of frons various, usually straighter, with surface shining or finely punctate (Figs. 12, 15) 6
6. Hindfemur about 5× as long as wide; frons smooth and more distinctly punctate, without anterior fine longitudinal wrinkles or group of wrinkles (Fig. 12); side of mesosoma granular, dull between sculpturation; orange or with thorax all or partly and top of head sometimes blackish; forewing with cell 1 + 2Rs receiving vein 2m-cu usually well beyond its middle; ovipositor sheath about 0.5× as long as forewing (Fig. 10) . . . . . *A. lovei* Ashmead
– Hindfemur about 6× as long as wide; frons with more wrinkles and less distinctly punctate, usually with an anterior median fine lon-



Figs. 1–5. *Aulacus impolitus.* 1, Lateral view. 2, Dorsal view of head and anterior mesosoma. Length, ca. 8 mm. *A. schiffi.* 3, Lateral view. 4, Mesosoma, lateral view. 5, Dorsal view of head and anterior mesosoma. Length, 6 mm.

gitudinal wrinkle, or group of wrinkles (Fig. 15); side of mesosoma shinier between sculpturation; entirely orange yellow; forewing with cell 1 + 2Rs receiving vein 2m-cu at or a little beyond its middle; ovipositor sheath about 0.75× as long as forewing (Fig. 13) . . . . . .*A. burquei* Provancher

7. Forewing black or black with a yellow cross band (Figs. 16–18) 8
– Forewing hyaline, subhyaline or suffused

with reddish brown, with or without dark spots or bands (Figs. 23, 28, 30, 34, 37) . . 9

8. Forewing with a median yellowish cross band; tibiae and tarsi black (Figs. 16, 17) . . . . . *P. fasciatus* (Say)

– Forewing entirely black; tibia and tarsi yellow (Fig. 18) . . . . . *P. violaceus* (Bradley)

9. Tarsal claws with a subapical large tooth and a subapical small tooth; forewing uniformly hyaline or slightly blackish, without spots (Fig. 23) (hindfemur black to dark brown) . 10

– Tarsal claws with three to four subapical teeth, of which the basal tooth is small; forewing nearly always with a dark spot below stigma and often with dark apical spot (Figs. 28, 30, 34, 37) 11

10. Side of mesosoma and hindcoxa polished with moderately coarse sculpture (Fig. 20); propleuron not distinctly punctured, shiny; posterior half of top of head with sparse fine punctures; hindtarsus whitish to light brown; apical half of female metasoma ferruginous, sometimes a little infuscate; first metasomal tergum (excluding the partly fused second tergum) of female about 1.5× as long as wide, of male about 1.9× as long as wide . . . . . *P. rufitarsis* (Cresson)

– Side of mesosoma and hindcoxa rather opaque and finely sculptured (Fig. 22); propleuron distinctly punctured; posterior half of top of head with dense fine punctures; hindtarsus dark brown; apical half of female metasoma black; first metasomal tergum (excluding the partly fused second tergum) of female about 1.3× as long as wide, of male about 1.5× as long as wide . . . . . *P. bilobatus* (Provancher)

11. Front margin of pronotum with a forward projecting, triangular tooth just above its midlength 12

– Front margin of pronotum without a distinct tooth near its midlength (but sometimes with an indistinct tooth near top) 13

12. Upper face of hindcoxa smooth, without cross wrinkles; tarsal claws with three subapical teeth; forewing with large dark spot below stigma and small apical dark spot (as in Fig. 30); hindfemur black, tibiae and fore- and midfemora yellow; occipital carina a narrow rim, less than 0.2× diameter of first flagellar segment (Fig. 25) . . . . . *P. flavicrurus* (Bradley)

– Upper face of hindcoxa with cross wrinkles; tarsal claws with four subapical teeth; forewing with small dark spot below stigma and small dark spot at central basal area (Fig. 28); femora and tibiae concolorous, legs beyond trochanters fulvous to black; occipital carina produced as a flange, somewhat reflexed, about 0.3× diameter of first flagellar segment (Fig. 27) . . . . . *P. niger* (Shuckard)

13. Upper side of hindcoxa smooth, without cross wrinkles; propleuron without distinct punctures (substigmal spot of forewing large, Fig. 30) . . . . . *P. strangaliae* (Rohwer)

– Upper side of hindcoxa with more or less distinct cross wrinkles; propleuron with weak to strong punctures 14

14. Occipital carina a reflexed flange that is about 0.4× as wide as basal flagellar segment and head behind eyes in dorsal view strongly convex (Fig. 33); wings slightly blackish, substigmal spot broad (Fig. 34) . . . . . *P. resutorivorus* (Westwood)

– Occipital carina a narrow rim, not more than 0.2× as wide as basal flagellar segment and head behind eyes in dorsal view less strongly convex (Fig. 36); wings hyaline, with narrow substigmal spot (Fig. 37) 15

15. Head from above narrowing behind eyes, distance from eye to occiput less than eye length (Fig. 36); mesoprescutum with distinct distinct, high transverse ridges (widely distributed in eastern North America) . . . . . *P. stigmaterus* (Cresson)

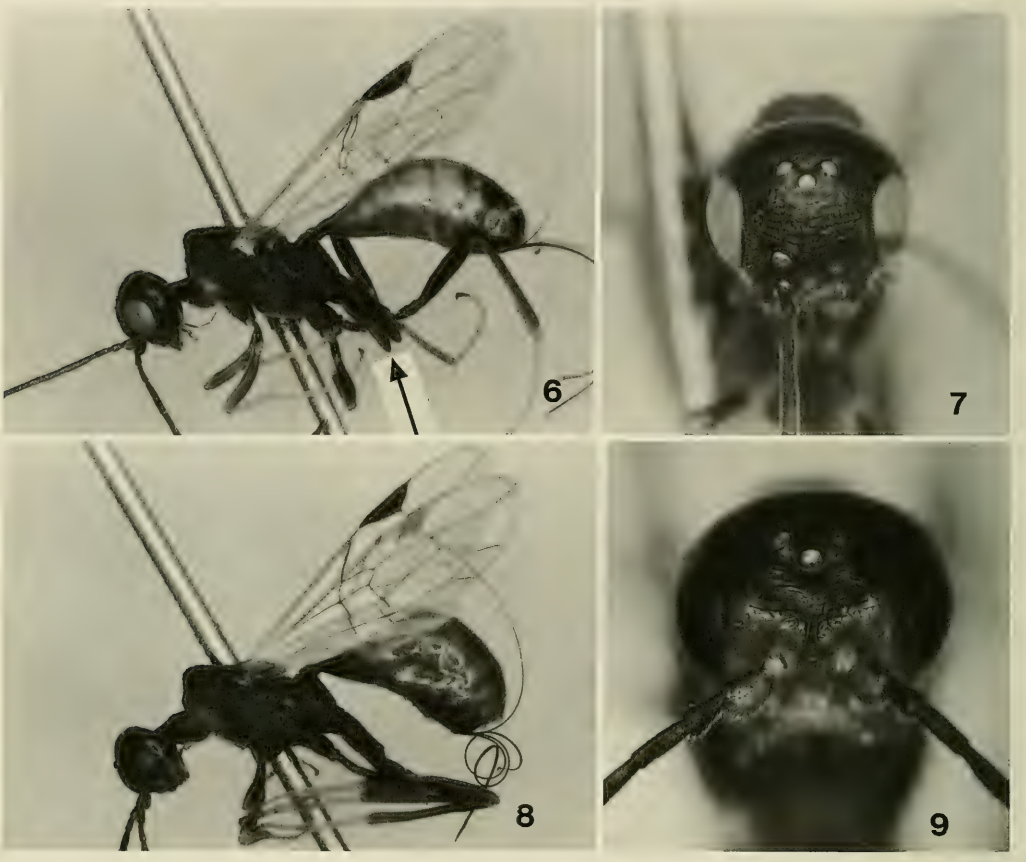
– Head from above long and with sides almost parallel behind eyes, distance from eye to occiput more than eye length; mesoprescutum smooth, without or with very weak transverse ridges (Maine, Ontario, Manitoba) . . . . . *P. canadensis* (Townes)

Aulacus burquei (Provancher) (Figs. 13–15, 38)

Diagnosis.—Uniformly orange to yellow; fine transverse wrinkles of frons confined to anterior region and mostly shining between, usually with fine median longitudinal carina; side of mesosoma shiny between sculpturation; hindfemur about 6× longer than wide; projecting ventral lobe of female hindcoxa about 1.2× longer than wide; ovipositor sheath about 0.7× length of forewing.

Distribution.—Indiana, Maine, Maryland, Michigan, New Hampshire, New York, Nova Scotia, Ontario, Pennsylvania, Quebec, Virginia.

Specimens examined.—Total: 63. MARYLAND: Prince George's Co., 3–15.V to 14–24.VI (10). VIRGINIA: Clarke Co., 22–31.V.1991, 3–15.VI.1992 (3; plus several reared by N. Schiff from *Acer*



Figs. 6–9. *Aulacus pallipes.* 6, Lateral view (arrow shows projecting ventral lobe of hindcoxa of female. 7, Anterior view of head. Length, ca. 7 mm. *Aulacus digitalis.* 8, Lateral view. 9, Anterior view of head. Length, ca. 7 mm.

branches containing *Xiphydria maculata,* maple branches collected 7.IV.1993, emerged 27.IV-1993 in lab); Essex Co., 15–28.V.1993, 10–27.VII.1993, 11–21.VI.1994 (4); Fairfax Co., 1–5.V to 25.VI–1.VII, most in May (39); Louisa Co., 13–27.V to 13–27.VII, most in May (7).

Hosts.—*Xiphydria maculata* Say (Xiphydriidae) in *Acer.* Above rearing from Clarke Co. From *Xiphydria* in *Acer* (Maryland); collected while ovipositing in *Acer* (New Hampshire); from *Xiphydria maculata* in *Acer* (Pennsylvania) (Townes 1950). From *Xiphydria maculata* in *Acer* and from *Carpinus caroliniana* Walt. in Indiana (Deyrup 1984).

Discussion.—Flight records for this species are from the first of May to the end of June, with the peak flight from mid-May through the first third of June (Fig. 38). Its flight coincides with the flight time of its host, *Xiphydria maculata,* which I have also collected at each of the above sites at about the same time. Deyrup (1984) reported both *A. burquei* and *A. digitalis* parasitizing *X. maculata* in Indiana. Even though there are several morphological differences separating the species, he found no ecological difference to explain the co-existence of both species. I have found both *Aulacus* species in the same habitats in the same traps. Nathan Schiff (personal communication) has also reared both species from *Acer* branches taken from the same site (see Clarke Co. records).

Aulacus digitalis Townes
(Figs. 8, 9)

Diagnosis.—Head brownish, darker above and behind; mesosoma dark brown to blackish; metasoma reddish with first segment black basally; legs light brown to blackish with second trochanters, extreme apices of femora, fore- and midtibiae, and tarsi paler; transverse wrinkles on frons confined to anterior part irregular, suffused with fine punctures; side of mesosoma dull between sculpturation; hindfemur about 5× longer than wide; projecting ventral lobe of female hindcoxa 1.4× or more longer than wide; ovipositor sheath about 0.9× forewing length

Distribution.—Connecticut, Indiana, Maryland, Massachusetts, Ohio, Ontario, Pennsylvania, Quebec, Virginia, West Virginia.

Specimens examined.—Total: 13. MARYLAND: Allegany Co., 10–20.VI.1993 (1); Prince George's Co., 24.V–3.VI.1991 (2). VIRGINIA: Clarke Co. (specimens reared by N. Schiff from *Acer* branches containing *Xiphydria maculata,* maple branches collected 7.IV.1993, emerged 27.IV.1993 in lab); Essex Co., 10–23.VI.1993 (2); Fairfax Co., 22–29.V to 12–20.VI (7); Louisa Co., 19–29.VI.1988 (1).

Hosts.—*Xiphydria maculata* in *Acer,* including the rearing above from Clarke Co. Emerged from dead wood (Connecticut); from *Xiphydria maculata* in *Acer saccharinum* L. (Connecticut); "reared from host in *Malus pumila*" (Connecticut); reared from host in dead *Acer* (Connecticut); reared from host in *Acer saccharum* Marsh. (West Virginia) (Townes 1950). From *Xiphydria maculata* in *Acer* from Indiana (Deyrup 1984).

Discussion.—I have found this species from the end of May to the end of June, a similar seasonal pattern as in *A. burquei* (see discussion under *A. burquei*).

Aulacus impolitus Smith
(Figs. 1, 2)

Diagnosis.—Entirely reddish brown to orange; head and mesosoma dull, with fine, granular surface sculpture; female hindcoxa without projecting ventral lobe; ovipositor sheath about 0.8× forewing length.

Distribution.—Virginia.

Specimens examined.—Total: 52. VIRGINIA: Clarke Co., 26.IV–9.V to 3–15.VI (51); Louisa Co., 13–27.V.1987 (1).

Host.—Unknown.

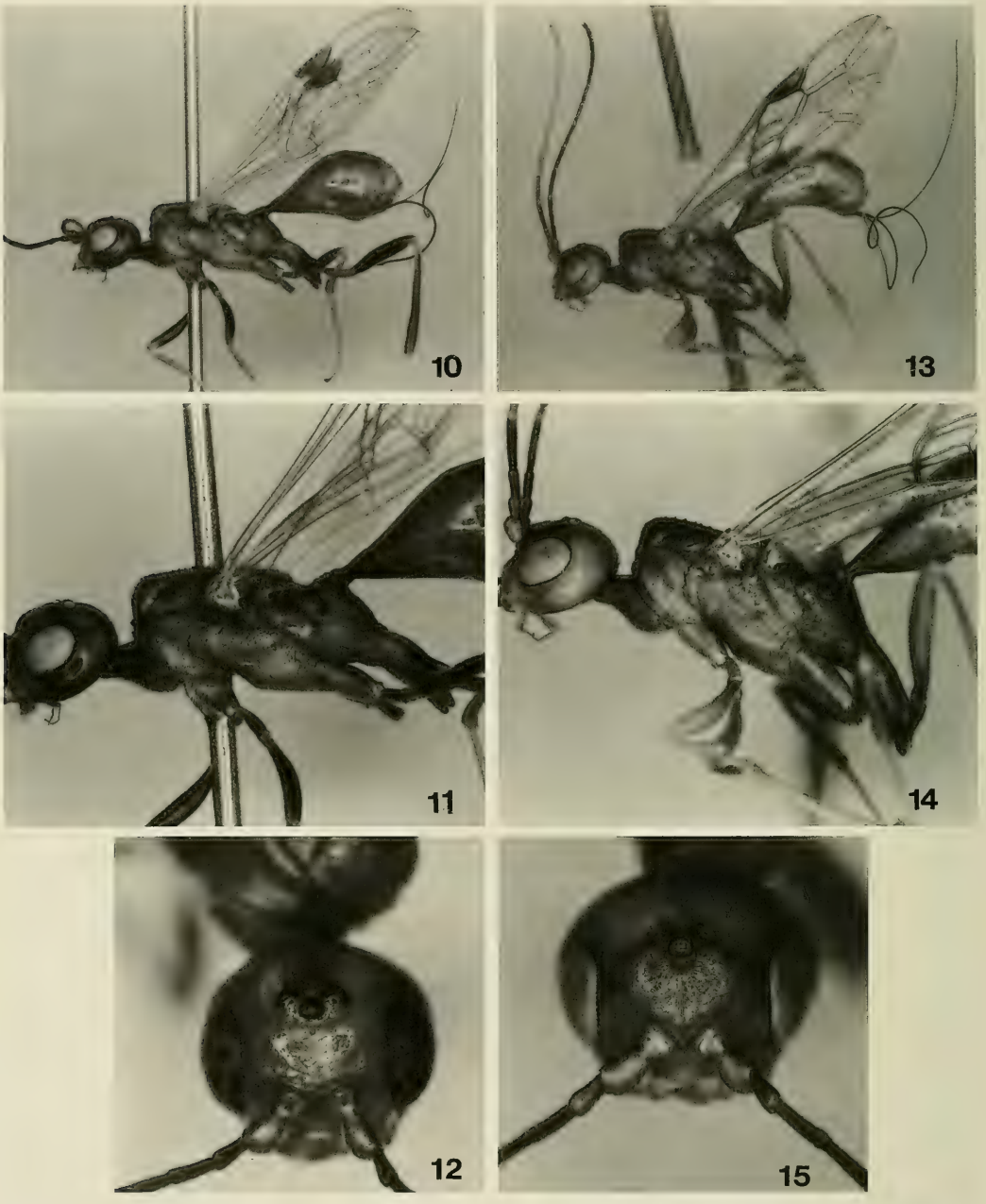
Discussion.—This species flies in May. Only three or four of the 52 specimens were taken in late April or early June. Most are from Clarke Co., from where the species was described (Smith 1991), and from traps set among willows and shrubbery around ponds and from traps set at the edge of an 80-year-old, elm-oak-hickory woodlot. It belongs to a group of *Aulacus,* characterized in the first half of the second couplet of the preceding key, that probably parasitizes wood-boring Coleoptera.

Aulacus lovei (Ashmead)
(Figs. 10–12, 38)

Diagnosis.—Color variable, usually orange brown to brown with top of head, mesosoma (mesoscutellum usually pale orange), and most of legs blackish to dark brown; metasoma reddish with base of first segment black; fine transverse wrinkles on frons confined to anterior portion, sometimes suffused with fine punctures; side of mesosoma dull between sculpturation; hindfemur about 5× longer than wide; projecting ventral lobe of female hindcoxa about 1.1× longer than broad; ovipositor sheath about 0.5× forewing length.

Distribution.—Connecticut, Georgia, Indiana, Maryland, Massachusetts, New Brunswick, New Jersey, New York, Nova Scotia, Ontario, Pennsylvania, Quebec, Tennessee, Vermont, Virginia, West Virginia.

Specimens examined.—Total: 33. MARYLAND: Allegany Co., 10–20.VI.1993 (2). VIRGINIA: Essex Co., 25.V–5.VI to 12–24.VI (8); Fairfax Co., 9–15.VI to 24–30.VI (4); Louisa Co., 15–27.V to 22.VI–3.VII (3). WEST VIRGINIA: Tucker Co., 9–19.VI to 9–19.VII (15); Hardy Co., 26.VI–4.VII.1994 (1).



Figs. 10–15. *Aulacus lovei.* 10, Lateral view. 11, Lateral view of mesosoma. 12, Anterior view of head. Length, ca. 6 mm. *Aulacus burquei.* 13, Lateral view. 14, Lateral view of mesosoma. 15, Anterior view of head. Length, ca. 8 mm.

Host.—*Xiphydria* (Xiphydriidae), mostly from *Carpinus* and *Tilia.* From *Xiphydria tibialis* in *Betula* (Maryland); from host in *Carpinus caroliniana* Walt. (Connecticut, Maryland, Pennsylvania); from *Carpinus* (Maryland); from host in *Tilia* (New York); from host in *Tilia americana* L. (Pennsylvania); from *Xiphydria* in *Tilia* (Pennsyl-

vania); from *Xiphydria attenuata* [= *X. abdominalis* Say] in *Tilia americana* (Pennsylvania) (mostly from Townes, 1950). Though *X. tibialis* may be a host for *A. lovei,* the most common *Xiphydria* species recorded from *Tilia* is *X. abdominalis* (Say) and from *Carpinus, X. champlaini* Rohwer and *X. scafa* Smith. Some or all may serve as hosts.

Discussion.—The flight time is from the end of May to mid-July, with most specimens taken from mid- to the end of June (Fig. 38). The flight is slightly later than those of *A. burquei* and *A. digitalis* and coincides with the flight time of *Xiphydria tibialis* Say, which was also taken at each of the above localities on about the same dates. *Xiphydria tibialis* is relatively common in traps, but I have also collected a few *X. scafa* and *X. abdominalis.* All three species normally fly later than does *X. maculata.*

Aulacus pallipes Cresson
(Figs. 6, 7)

Diagnosis.—Color variable, usually black with legs dark brown and apices of tibiae and tarsi yellowish; metasoma reddish with basal part of first tergum black and apical third blackish; ridges and reticulations of frons coarse and extending almost to middle ocellus; side of mesosoma dull between sculpturation; hindfemur about 5× longer than wide; projecting ventral lobe of female hindcoxa about 1.3× longer than wide; ovipositor sheath about as long as forewing.

Distribution.—British Columbia, Idaho, Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Brunswick, New York, Northwest Territories, Ontario, Pennsylvania, Quebec, Rhode Island, Washington, Virginia, West Virginia.

Specimens examined.—Total: 2. MARYLAND: Garrett Co., 30.VI–10.VII.1993 (1). WEST VIRGINIA: Tucker Co., 19–29.VI.1993 (1).

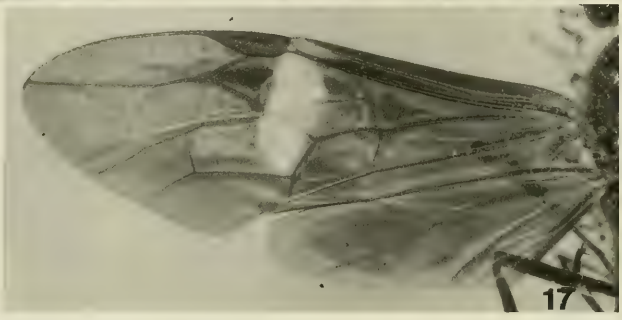
Hosts.—*Xiphydria mellipes* Harris in *Betula.* Reared records include *X. mellipes* from *Betula lutea* Michx. f., *Betula nigra* L., yellow birch or birch, and *Xiphydria* sp. from *Betula* sp., mostly from northern states (Townes 1950). Some labels record the host as *Xiphydria mellipes* without the host tree (Massachusetts, Missouri, New York, Virginia).

Discussion.—This species is associated with *X. mellipes* Harris, a more northern species that attacks *Betula.* Both collection localities were in the Appalachians at over 2600 ft. elevation. *Xiphydria mellipes* was also collected at the Tucker Co. site.

***Aulacus schiffi* Smith, New Species**
(Figs. 3–5)

Diagnosis.—Almost entirely black with scape, pedicel, narrow posterior bands on metasomal segments and part of legs brownish; frons and top of head smooth, shining, with very few fine punctures; mesosoma shining between sculpturation; ovipositor sheath about 0.5× forewing length.

Female.—Length, 6.0 mm. Antenna black, scape and pedicel pale brown to orange; head black, mandible brownish; mesosoma black; metasoma black with brownish, narrow posterior bands on terga; legs black with following pale brown: trochanters, outer surface of forefemur, apex of midfemur; fore- and midtibia, extreme base of hindtibia, and tarsi. Wings clear hyaline; veins and stigma black. Antenna 14-segmented; 2nd flagellar segment longer than 1st and 3rd flagellar segments. Frons and top of head smooth and shining, without surface sculpture or wrinkles, but with few very fine widely scattered punctures; occipital carina absent and back of head without wrinkles in position of occipital carina. Side of mesosoma shiny between coarse ridges and reticulations; mesoprescutum with transverse ridges; mesonotal lateral lobes and mesoscutellum reticulate. Vein 2m-cu in forewing present. Hindcoxa without projecting ventral lobe; inner side of hindcoxae without a channel. Ovipositor about 0.5× as long as forewing.



Figs. 16–18. *Pristaulacus fasciatus.* 14, Forewing. 15, Lateral view. Length, ca. 16 mm. *Pristaulacus violaceus.* 18, Lateral view, male. Length, ca. 13 mm.

Male.—Unknown. See discussion.

Holotype.—Female, labeled "MARYLAND: Prince George's Co., Beltsville Agric. Res. Center, 39°02′N 76°52′W, D. Barriner and T. Smith," "26-VI-6-VII-1993, coniferous forest, Malaise trap #1." Deposited in the National Museum of Natural History, Washington, D.C.

Host.—Unknown. Belongs to the group of *Aulacus* that probably parasitize woodboring Coleoptera.

Discussion.—A male from "Thwartway Island, St. Lawrence Is. National Park, Ontario," "A. Carter, Aug. 2, 1976, Malaise trap code 4276-N" may be the male of this species. It is similar to the female except for the legs which are entirely yellow orange beyond the coxae.

This species belongs in the group of *Aulacus* characterized in the first half of couplet two of the preceding key. Besides *A. impolitus* and *A. schiffi,* three other species belong here, *A. dispilis* Townes (Texas), *A. brevicaudus* (Cushman) (Oregon, California), and *A. aneurus* Walkley (New Mexico). The shiny, impunctate, smooth texture of the frons and top of the head place *A. schiffi* close to *A. brevicaudus.* The frons and top of the head of all other species are dull and minutely granular (*A. aneureus, A. impolitus*), or have large scattered deep punctures (*A. dispilis*); the forewing of *A. dispilis* has an apical dark spot, and the head and mesosoma are reddish; *A. impolitus* is entirely reddish brown; *A. brevicaudus* also has a black head and thorax but differs from *A. schiffi* by the orange metasoma and orange legs beyond the trochanters; and *A. aneurus* Walkley is mostly black but has very fine transverse striae on the mesosotum, whereas the mesonotum of *A. schiffi* has very coarse transverse ridges.

The holotype was taken in a trap in a coniferous forest habitat in a opening on the east bank of Beaver Dam Lake.

Etymology.—This species is named for my colleague Dr. Nathan Schiff, Bee Research Laboratory, U.S.D.A., Beltsville, Maryland.

Pristaulacus bilobatus (Provancher)
(Figs. 21–23)

Diagnosis.—Most likely confused with *P. rufitarsis,* the only two species without darks spots in the forewing and the tarsal claws with two subapical teeth. Black; metasoma reddish with apical segments black; fore- and midtibiae and tarsi and sometimes fore- and midfemora brownish; forewing uniformly hyaline, without black spots; tarsal claws with two subapical teeth; propleuron punctured, side of mesosoma rather dull, punctured, and finely sculptured.

Distribution.—Michigan, New Hampshire, New Jersey, New York, Nova Scotia, North Carolina, Ohio, Ontario, Pennsylvania, West Virginia, Wisconsin.

Specimens examined.—None.

Hosts.—Most rearing records give the host as *Melanophila fulvoguttata* (Harris) (Buprestidae), or as *Melanophila,* and reared from hemlock, *Tsuga canadensis* (L.) Carr. (Townes 1950).

Discussion.—Though recorded from West Virginia and North Carolina, I did not collect *P. bilobatus.* Because it is mainly associated with buprestids in hemlock, it may occur only at higher elevations in habitats where I have not collected. Townes (1950) records this species from the end of May to mid-August.

Pristaulacus fasciatus (Say)
(Figs. 16, 17)

Diagnosis.—Entirely black; wings black with yellowish cross band immediately anterior to stigma.

Distribution.—Arkansas, District of Columbia, Georgia, Illinois, Indiana, Maryland, Michigan, Mississippi, Missouri, Pennsylvania, Texas, Virginia.

Specimens examined.—Total: 4. MARYLAND: Prince George's Co., 17.VII–2.VIII.1991 (1). VIRGINIA: Clarke Co., 21.VII–1.VIII.1991, 8–25.VIII.1992 (2); Essex Co., 1–14.VIII.1992 (1).

Hosts.—Reared from *Carya ovata* (Mill.) K. Koch (Pennsylvania) (Townes 1950).

Discussion.—This is a late flying species, from the end of July into August. It is not commonly collected.

Pristaulacus flavicrurus (Bradley)
(Figs. 24, 25, 39)

Diagnosis.—Black; metasoma reddish with base and apex black; hindfemur black, tibiae and fore- and midfemora yellowish; forewing with large substigmal and small apical dark spots; front margin of pronotum with forward projecting tooth at midlength; tarsal claws with three subapical teeth; upper face of hindcoxa smooth, without cross wrinkles; occipital carina a narrow rim.

Distribution.—Georgia, Maryland, Michigan, New York, North Carolina, Ohio, Ontario, Pennsylvania, South Carolina, Vermont, Virginia, West Virginia.

Specimens examined.—Total: 45. MARYLAND: Allegany Co., 21–30.VI.1993 (1); Garrett Co., 10–20.VI to 30.VI–9.VII (11); Prince George's Co., 10–23.VI to 15–25.VI (5). VIRGINIA: Clarke Co., 15–24.VI to 25.VI–5.VII (7); Fairfax Co., 13–19.VI.1993 (1). WEST VIRGINIA: Tucker Co., 9–19.VI to 19–28.VII (20).

Hosts.—Unknown.

Discussion.—Flight records are from the first of June to the end of July, with most specimens collected from mid-June to the first of July (Fig. 39).

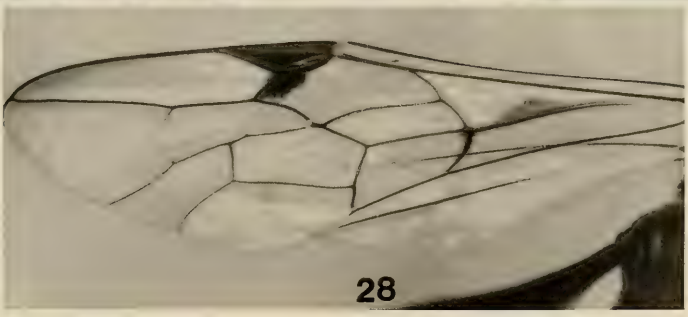
Pristaulacus niger (Shuckard)
(Figs. 26–28)

Diagnosis.—Black; metasoma reddish only on first and second segments; legs usually orange beyond coxae (variable, sometimes blackish); forewing with small sub-

Figs. 19–23. *Pristaulacus rufitarsis* 19, Head, dorsal view. 20, Lateral view of mesosoma. Length, ca. 11 mm. *Pristaulacus bilobatus*. 21, Head, dorsal view. 22, Lateral view of mesosoma. 23, Lateral view. Length, ca. 9.5 mm.

stigmal and small basal central spots; front margin of pronotum with forward projecting tooth at midlength; tarsal claws with four subapical teeth; upper face of hindcoxa with cross wrinkles; occipital carina with rather broad, somewhat reflexed, flange about 0.3× width of first flagellar segment.

Distribution.—Alabama, Colorado, Florida, Georgia, Louisiana, Manitoba, Maryland, Massachusetts, Michigan, Minnesota,

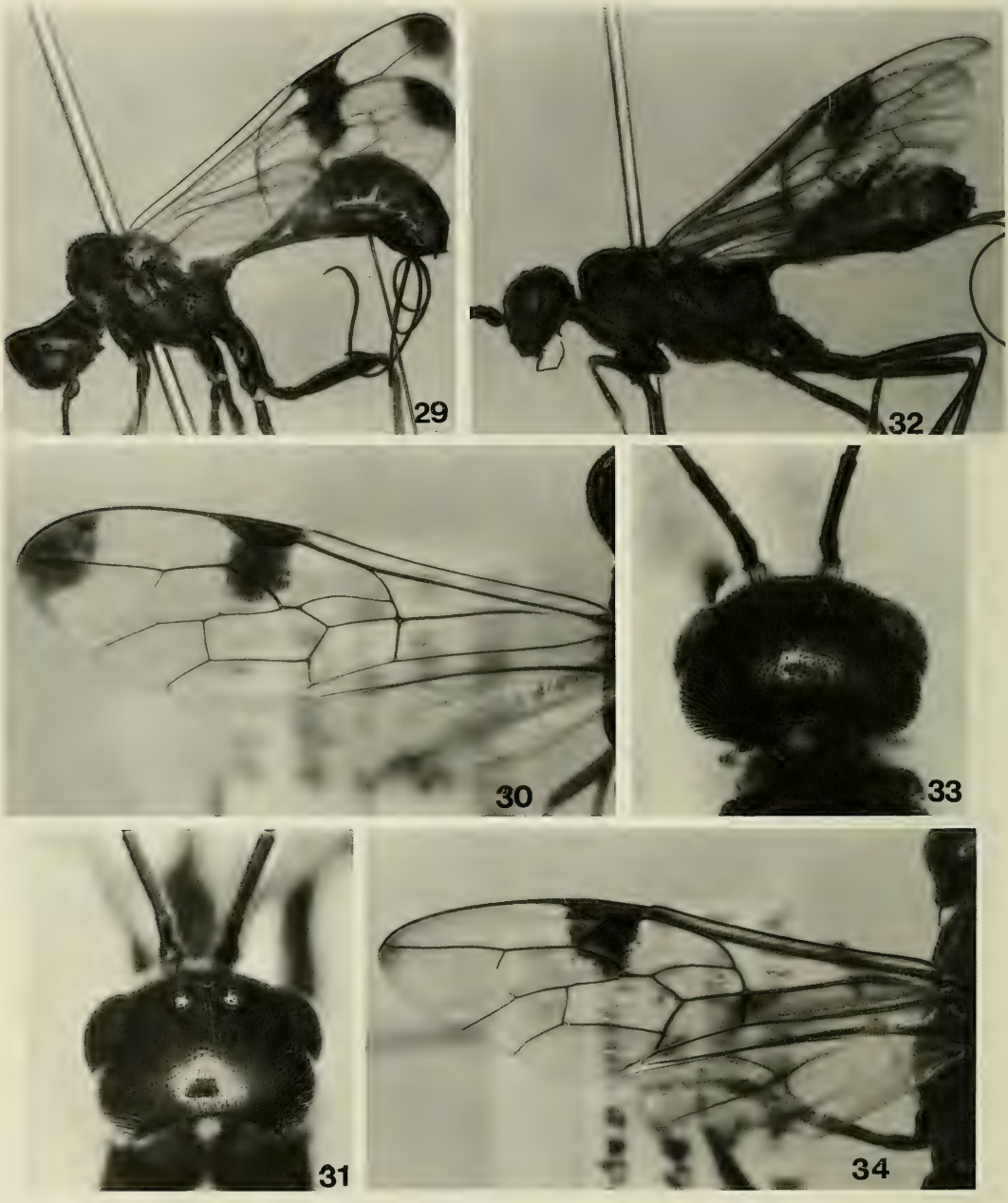


Figs. 24–28. *Pristaulacus flavicrurus.* 24, Lateral view. 25, Head, dorsal view. Length, ca. 11 mm. *Pristaulacus niger.* 26, Lateral view. 27, Head, dorsal view. 28, Forewing. Length, ca. 13 mm.

New York, North Carolina, Ontario, Pennsylvania, Quebec, Texas, Virginia.

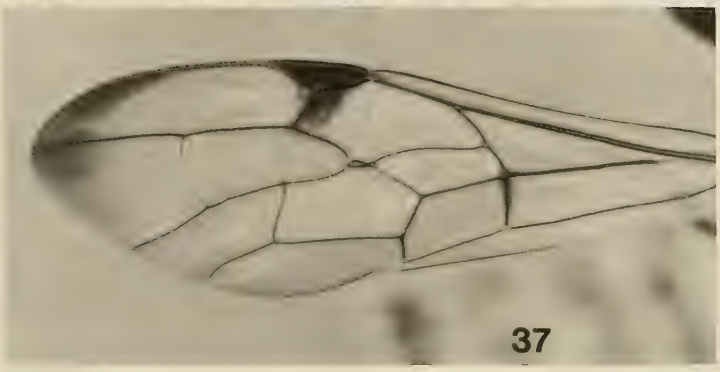
Specimens examined.—Total: 6. VIRGINIA: Essex Co., 11.X–5.XI.1991 (1); Fairfax Co., 19–26.VI to 19–26.VII (5).

Hosts.—Has been collected on and reared from *Pinus* (Townes 1950). Haack and Wilkinson (1987) reared *P. niger* from *Pinus elliottii* Engelm. in Florida as well as the following Cerambycidae which they re-



Figs. 29–34. *Pristaulacus strangaliae.* 29, Lateral view. 30, Forewing. 31, Head, dorsal view. Length, ca. 12 mm. *Pristaulacus resutorivorus.* 32, Lateral view. 33, Head, dorsal view. 34, Forewing. Length, ca. 11 mm.

garded as suspected hosts: *Neacanthocinus obsoletus* (Olivier), *Tylocerina nodosus* (F.), *Monochamus titillator* (F.), and *Xylotrechus sagittatus sagittatus* (Germar). I have seen records from *Pinus rigida* Mill. (New York), *Pinus echinata* Mill. (Georgia), *Pinus virginiana* Mill. (Virginia), *Pinus taeda* L. (North Carolina), and *Abies balsamea* (L.) Mill. and *Larix laricina* (Du Roi) K. Koch (Minnesota). Specimens from Louisiana are labeled "ex loblolly pine infested with cerambycids," and specimens from



Figs. 35–37. *Pristaulacus stigmaterus.* 35, Lateral view. 36, Head, dorsal view. 37, Forewing. Length, ca. 9 mm.

Georgia are labeled "ovipositing on southern pine beetle infested Virginia pine" and "ovipositing on southern pine beetle infested white pine."

Discussion.—Most collection records are from mid-June to mid-July. The one record from Essex Co. is the latest I have trapped an aulacid.

Pristaulacus resutorivorus (Westwood)
(Figs. 32–34)

Diagnosis.—Black; metasoma mostly reddish with black above at apex; legs beyond first trochanters dark reddish to black; wings slightly blackish with large substigmal and small apical dark spots; front margin of pronotum without forward projecting tooth; upper face of hindcoxa with cross wrinkles; head short behind eyes and strongly convex; occipital carina a reflexed flange about 0.4× width of basal flagellar segment.

Distribution.—Alberta, British Columbia, California, Colorado, Connecticut, District of Columbia, Georgia, Idaho, Maine, Maryland, Mississippi (?), Michigan, Montana, Ontario, Oregon, Pennsylvania, Quebec, Virginia, Washington.

Specimens examined.—Total: 18. MARYLAND: Allegany Co., 30.VI–9.VII to 10–19.VII (3). VIRGINIA: Clarke Co., 30.VI–9.VII.1992, 17–30.VI.1993 (2); Essex Co., 6–14.VI.1991 (1); Fairfax Co., 11–17.V to 6–12.VIII (12).

Hosts.—Notes on specimens associate this species with *Pinus* (Townes 1950). Carlson (1979) gave *Arhopalus productus* (LeConte) (Cerambycidae) as a question-

able host record. His record is probably from specimens labeled "em. in Athens Ga., ex *Arhopalus productus* in Doug.-fir lumber of new house" from Vancouver, B. C., and from Jackson, Mississippi "ex lumber of new house yielding *Arhopalus productus.*" I have seen specimens labeled *Pinus lambertiana* Dougl. (Oregon) and *Pseudotsuga menziesii* (Mirb.) Franco (as *P. taxifolia*) (Montana). One specimen from Georgia is labeled "ovipositing on southern pine beetle infested Virginia pine."

Discussion.—Specimens have been caught from mid-May to the first of August, with most from the first of June to mid-July.

Pristaulacus rufitarsis (Cresson)
(Figs. 19, 20)

Diagnosis.—Black; metasoma reddish; legs black with tarsi reddish orange and sometimes fore- and midtibiae dark orange; wings uniformly hyaline, without dark spots; tarsal claws with two subapical teeth; propleuron and side of mesosoma shining and not distinctly punctured, polished with moderately coarse sculpture.

Distribution.—Alaska, Alberta, Arizona, British Columbia, California, Colorado, Idaho, Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Brunswick, New Hampshire, New Mexico, New York, North Carolina, Northwest Territories, Ontario, Oregon, Pennsylvania, Prince Edward Island, Quebec, Saskatchewan, Vermont, Virginia, Washington, Wyoming, Yukon Territory.

Specimens examined.—Total: 5. MARYLAND: Prince George's Co., 17.VII–2.VIII.1991, 25.VII–8.VIII.1992 (2). VIRGINIA: Essex Co., 28.VI–11.VII.1991, 28.VII–13.VIII.1993 (2); Fairfax Co., 12–18.VI.1988 (1).

Hosts.—Buprestidae and Cerambycidae mostly from conifers. Reared from *Chrysobothris caurina* Horn (Buprestidae) in *Pinus ponderosa* Dougl. ex Laws. (California); from *Melanophila fulvoguttata* (Buprestidae) in *Tsuga canadensis* (New Hampshire); from *Melanophila drummondi* (Kirby) in *Abies concolor* (Gord. & Glend.) Lindl. (California); from *Saperda calcarata* Say (Cerambycidae) in *Populus tremuloides* Michx. (Colorado); other records from *Pinus arizonica* (Engelm.) Shaw (Arizona) and *Tsuga mertensiana* (Bong.) Carr. (Oregon) (Townes 1950; Carlson 1979). From *Graphisurus* sp. (Cerambycidae) (Carlson 1979). I have seen specimens labeled "ex *Chrysophana placida* [Buprestidae] in cone of *Pinus attenuata*" (California); from *Libocedrus decurrens* Torr., *Abies concolor,* and *Pinus lambertiana* (California), and *Pinus flexilus* James (Idaho).

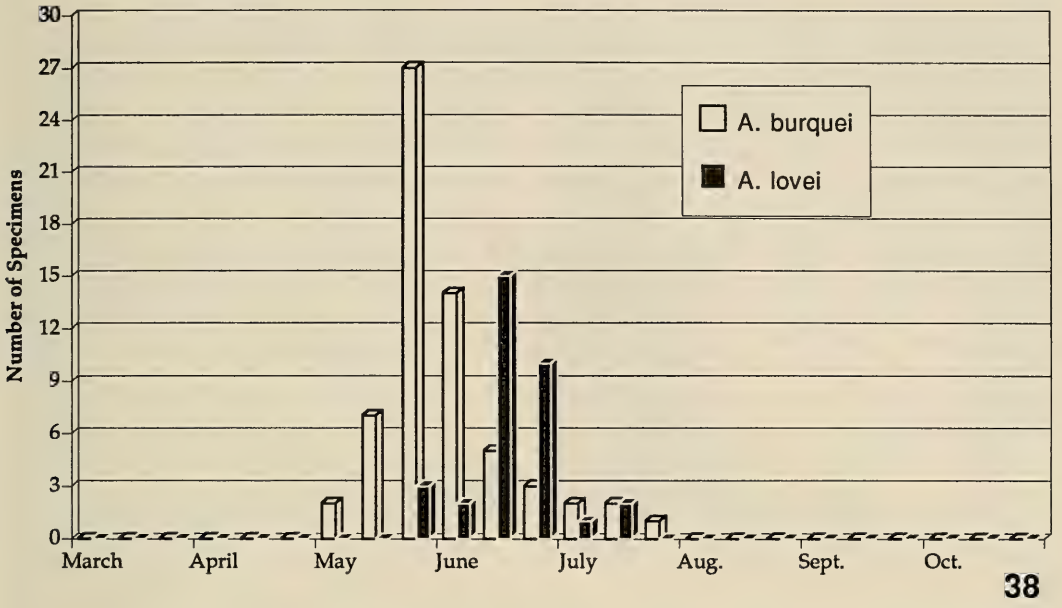
Discussion.—I have found this species from mid-June to the first of August. It is not common in collections.

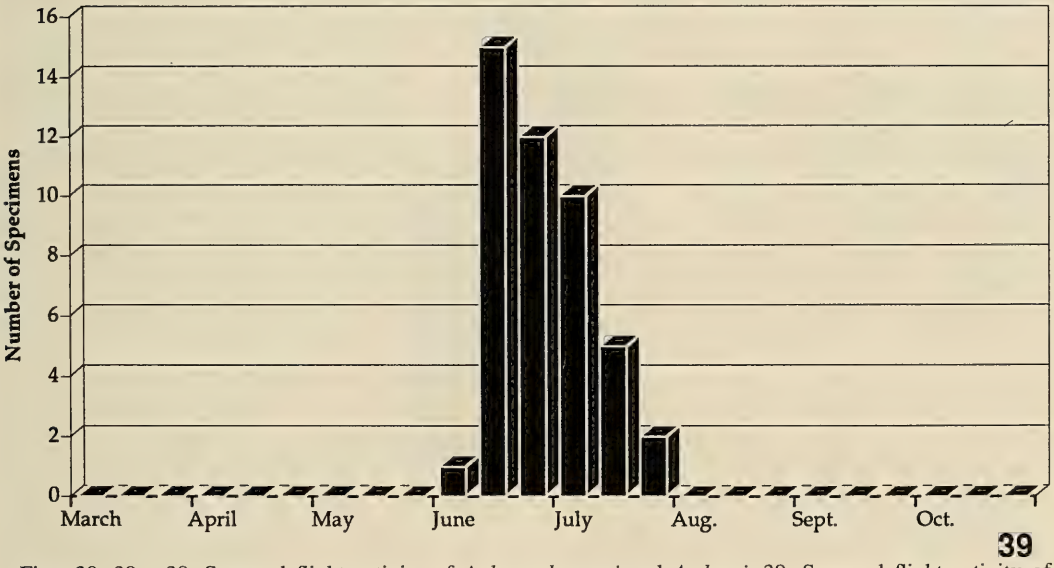
Pristaulacus stigmaterus (Cresson)
(Figs. 35–37, 40)

Diagnosis.—Black; metasoma reddish with apex black; legs orange beyond coxae with hindfemur darker brownish; forewing hyaline with small substigmal and apical dark spots; front margin of pronotum without forward projecting tooth; tarsal claws with three subapical teeth; upper face of hindcoxa with numerous cross wrinkles; head behind eyes not strongly convex; occipital carina a narrow rim, 0.2× or less width of basal flagellar segment.

Distribution.—Arkansas, Connecticut, Georgia, Maryland, Massachusetts, Michigan, Missouri, New York, Ohio, Ontario, Quebec, Rhode Island, Virginia, West Virginia.

Specimens examined.—Total: 203. MARYLAND: Allegany Co., 10–19.VI to 10–19.VII (18); Garrett Co., 30.VI–9.VII.1992, 21–30.VI.1993 (3); Prince George's Co., 3–15.V to 27.VI–10.VII (23). VIRGINIA: Clarke Co., 10–21.V to 15–24.VI (60); Essex Co., 30.IV–13.V to 12–24.VI (53); Fairfax Co., 22–28.V to 5–11.VI (4); Louisa Co., 13–26.V to 1–12.VII (28). WEST VIRGINIA: Randolph Co., 8–18.VII.1993 (1); Tucker Co., 30.V–9.VI to 9–18.VII (3); Hardy Co., 15.V–10.VI to 5–18.VII (10).





Figs. 38, 39. 38, Seasonal flight activity of *Aulacus burquei* and *A. lovei.* 39, Seasonal flight activity of *Pristaulacus flavicrurus.* Both graphs based on cumulative data from all collections.

Hosts.—Unknown. I have seen specimens labeled "Myrica certifera" (Connecticut) and "elm spanworm associate" (Georgia).

Discussion.—This species flies from the first of May to the first of June, with the peak flight from mid-May to mid-June (Fig. 40). It is the second most commonly collected species of *Pristaulacus* and occurs in the same habitats as *P. strangaliae,* but the flight period is slightly earlier than that species.

Pristaulacus strangaliae (Rohwer)
(Figs. 29–31, 41)

Diagnosis.—Black; metasoma reddish with apex black; legs orange beyond coxae with hindfemur darker brownish; forewing

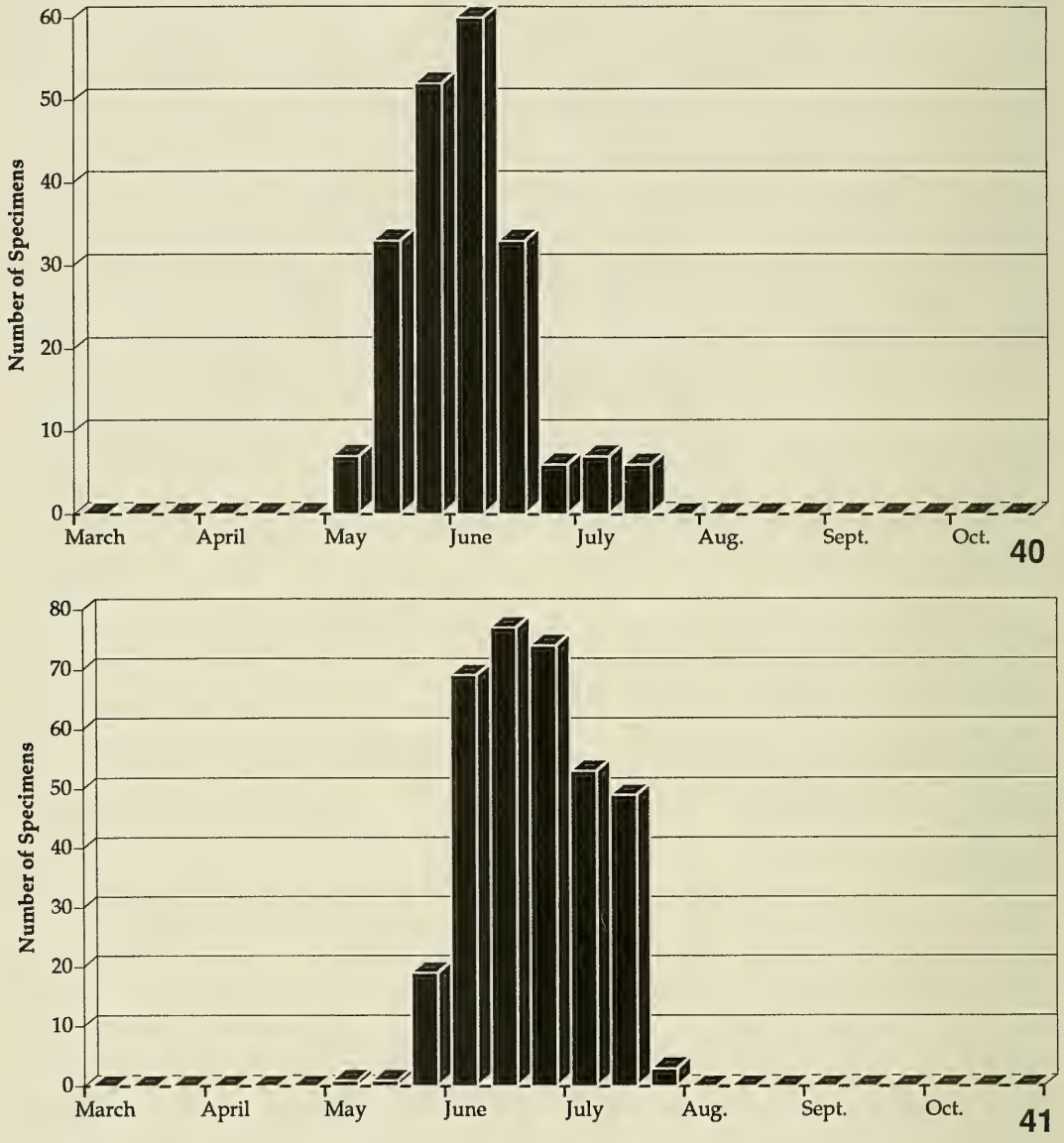


Fig. 40, 41. 40, Seasonal flight activity of *Pristaulacus stigmaterus*. 41, Seasonal flight activity of *Pristaulacus strangaliae*. Both graphs based on cumulative data from all collections.

hyaline with large substigmal and small apical dark spots; front margin of pronotum without forward projecting tooth; tarsal claws with three subapical teeth; upper face of hindcoxa smooth, without cross wrinkles.

Distribution.—Connecticut, District of Columbia, Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, New Brunswick, New Hampshire, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Ontario, Pennsylvania, Prince Edward Island, Quebec, Rhode Island, Virginia, West Virginia.

Specimens examined.—Total: 345. MARYLAND: Allegany Co., 31.V–10.VI to 20–29.VII (61); Garrett Co., 31.V–10.VI to 10–19.VII (7); Prince George's Co., 16–23.V to 8–20.VII (92). VIRGINIA: Clarke

Co., 1–11.VI to 1–14.VII (7); Essex Co., 4–17.V to 12–24.VI (18); Fairfax Co., 2–8.VI to 18–24.VI (4); Louisa Co., 13–26.V to 19–29.VI (47). WEST VIRGINIA: Tucker Co., 31.V–9.VI to 9–19.VII (105); Hardy Co., 5–10.VI to 5–18.VII (4).

Hosts.—Records are from Cerambycidae in deciduous trees. Reared from *Anoplodera proxima* (Say) (Cerambycidae) in *Fagus* (Pennsylvania); from *Anoplodera mutabilis* in *Alnus* (Pennsylvania); from *Anoplodera rubrica* (Say) in *Tsuga* (Pennsylvania); from *Anoplodera rubrica* in *Carpinus* (Pennsylvania); from *Ostrya* (Connecticut); collected from dead branches of *Carpinus* (Townes 1950). I have seen specimens labeled "reared from dead elm and birch infested by *Leptura rubrica* [Cerambycidae], *Typocerus velutinus* [Cerambycidae]" (Pennsylvania); *Carpinus caroliniana* (Pennsylvania, Maryland); *Ostrya virginiana* (Mill.) K. Koch (Connecticut); and "birch log" (Maine).

Discussion.—This is the most common species of aulacid and is prevalent in woods and forest situations. It flies from the first of May to the end of July, with the peak flight from the first of June to mid-July (Fig. 41). Though in the same habitats as *P. stigmaterus,* the flight time is slightly later.

Pristaulacus violaceus (Bradley)
(Fig. 18)

Diagnosis.—Black with tibiae and tarsi yellow; wings uniformly black.

Distribution.—District of Columbia, Ohio, Virginia.

Specimens examined.—none.

Hosts.—Unknown.

Discussion.—I did not collect this species. There is one record from the District of Columbia and one record from Nelson County, Virginia, July 24, 1927.

Acknowledgments

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MORPHOLOGY OF *NEPHASPIS OCULATUS* AND *DELPHASTUS PUSILLUS* (COLEOPTERA: COCCINELLIDAE), PREDATORS OF *BEMISIA ARGENTIFOLII* (HOMOPTERA: ALEYRODIDAE)

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Abstract.—Two coccinellids, *Nephaspis oculatus* (Blatchley) and *Delphastus pusillus* (LeConte), are potentially good biological control agents of *Bemisia argentifolii* Bellows and Perring in Florida and elsewhere. The two species share many features of morphology and biology. We describe and compare the eggs, larvae, pupae and adults of the two coccinellids and provide detailed illustrations of all stages.

Key Words: Coccinellids, predators, whitefly, biological control

Nephaspis oculatus (Blatchley) and *Delphastus pusillus* (LeConte) are predacious coccinellids that have shown potential for biological control of *Bemisia argentifolii* Bellows and Perring in greenhouses (Hoelmer et al. 1993, Heinz et al. 1994, Heinz and Parrella 1994, Liu, unpublished data). *Nephaspis oculatus* is well established in Florida where it probably entered from its native Central America on imported plant material (Gordon 1972, 1985). Misidentified as *N. gorhami* Casey, beetles from Central America were released and established in California to control citrus whitefly (Rose and DeBach 1981). As *N. amnicola* Wingo, it was introduced from Honduras, Trinidad, and the West Indies to Hawaii in 1979–1980 where it has become effective in biological control of the spiraling whitefly, *Aleurodicus dispersus* Russell (Kumashiro et al. 1983). *Nephaspis oculatus* has been observed preying on *B. argentifolii* in Florida (Hoelmer et al. 1994, Liu unpublished data), but we are unaware of published studies on this prey relationship.

Delphastus pusillus has been recorded from 22 states of the United States, and noted to feed on many species of Aleyrodidae (Gordon 1970, 1975), including *Aleurocanthus woglumi* Ashby, *Pealius kelloggi* (Bemis), *Trialeurodes floridensis* (Quaintance), *Dialeurodes citri* (Ashmead), and *D. citrifolii* (Morgan). The earliest record of *D. pusillus* in the Florida State Collection of Arthropods (Gainesville, FL) was made by A. J. Mutohler in 1918 based on specimens collected from citrus infested with *D. citrifolii* and *D. citri. Delphastus pusillus* is one of the most common predators on citrus in Florida associated with high populations of several species of whiteflies (*D. citrifolii, D. citri,* and *Aleurocanthus woglumi* Ashby), purple scale (*Lepidosaphes beckii* [Newman]), and twospotted spider mite (*Tetranychus urticae* [Koch]) (Muma 1956, Cherry and Dowell 1979). More recently, *D. pusillus* has been found associated with high populations of silverleaf whitefly, *B. argentifolii,* reported as *B. tabaci* (Gennadius), on many ornamental plants in Florida (Hoelmer et al. 1993, 1994). Hoelmer et al. (1993) concluded that high consumption

rates of whitefly eggs by *D. pusillus* would favor suppression of heavy whitefly infestations, and that the ability to use alternative prey would favor survival when whitefly populations were low. The potential of this beetle as a biological control agent for *B. argentifolii* on greenhouse-grown poinsettia and cotton in conjunction with *Encarsia* spp. parasitoids was favorably evaluated in California (Heinz et al. 1994, Heinz and Parrella 1994).

The two species belong to different subfamilies: Sticholotidinae (tribe Serangiini) (*D. pusillus*), and Scymninae (tribe Scymnini) (*N. oculatus*). Adult characters which can be used to separate the two subfamilies include the apical segment of maxillary palpus, which is cornical or elongate oval in Sticholotidinae, but parallel sided or somewhat securiform in Scymninae, the mentum which is narrowly articulated with submentum in Sticholotidinae but broadly articulated with submentum in Scymninae, and the antennal insertion which is dorsal in Sticholotidinae, but short and inserted ventrally in Scymninae. Classification above the genus level using larval characters is not as well studied (Rees et al. 1994), but the two subfamilies can be separated by hairs and setae which are dense, long and fine in Sticholotidinae but limited to a few large setae on tubercles or strumae in Scymninae, and the mandibles which lack a retinaculum in Sticholotidinae, but have the retinaculum present in Scymninae.

Rees (1948) compared the morphology of *D. pusillus* larvae with *Catana clauseni* Chapin, and Yoshida and Mau (1985) described *N. amnicola* (= *N. oculatus*) in their biological study. However, their descriptions are brief and lack detailed illustrations. The two coccinellids are often confused because of their small size and similar morphology and biology. Given their likely roles in future biological control efforts, more detailed morphological and biological information is desirable. Here, we describe, illustrate and compare eggs, larvae, pupae, and adults of the two coccinellids.

Material and Methods

Description and illustration of all developmental stages of *N. oculatus* were based on fresh specimens collected from a greenhouse culture reared on *B. argentifolii* maintained on collards (*Brassica oleracea* L. var. *acephala,* 'Georgia LS'). Fresh specimens of *D. pusillus* were obtained from a collard and eggplant-based whitefly culture, and was initiated with pupae and adults provided by J. Nelson (University of California, Davis) originally from Florida, and reared on poinsettia (*Euphorbia pulcherrima* Willd.). Dry specimens collected in Florida by K. Hoelmer (USDA-APHIS, Brawley, CA) were also used for description and illustration. Temporary mounts of adult antennae were made on temporary microscopic slides for detailed examination. The adult abdomen was detached from the thorax to examine postcoxal lines. Larvae were mounted in Hoyer's mounting medium for microscopic examination. Voucher specimens were deposited either dried (adults, and larvae on microscope slides) or in alcohol (larvae and eggs) in the Insect Collection, Southwest Florida Research & Education Center, University of Florida, Immokalee.

Morphological terms used in the descriptions include the following: *struma:* mound like projection bearing few chalazae (Fig. 1K); *chalaza:* projection of the body wall bearing a seta (Fig. 1L); *collar seta,* seta surrounded by a raised collar at the base (Fig. 1M); *asperities,* small spinelike structures frequently arranged in rows or confined to specific areas (Fig. 2I). These terms are based on Peterson (1962), Gordon (1985), Gordon and Hilburn (1990), LaSage (1991), and Rees et al. (1994).

Body length and width of adult and eggs, and body length and head (capsule) width of each larval instar were measured at the longest and widest points using a stereo dissecting microscope equipped with a calibrated ocular micrometer (± 0.0025 mm). Each larval instar was measured <24 h af-

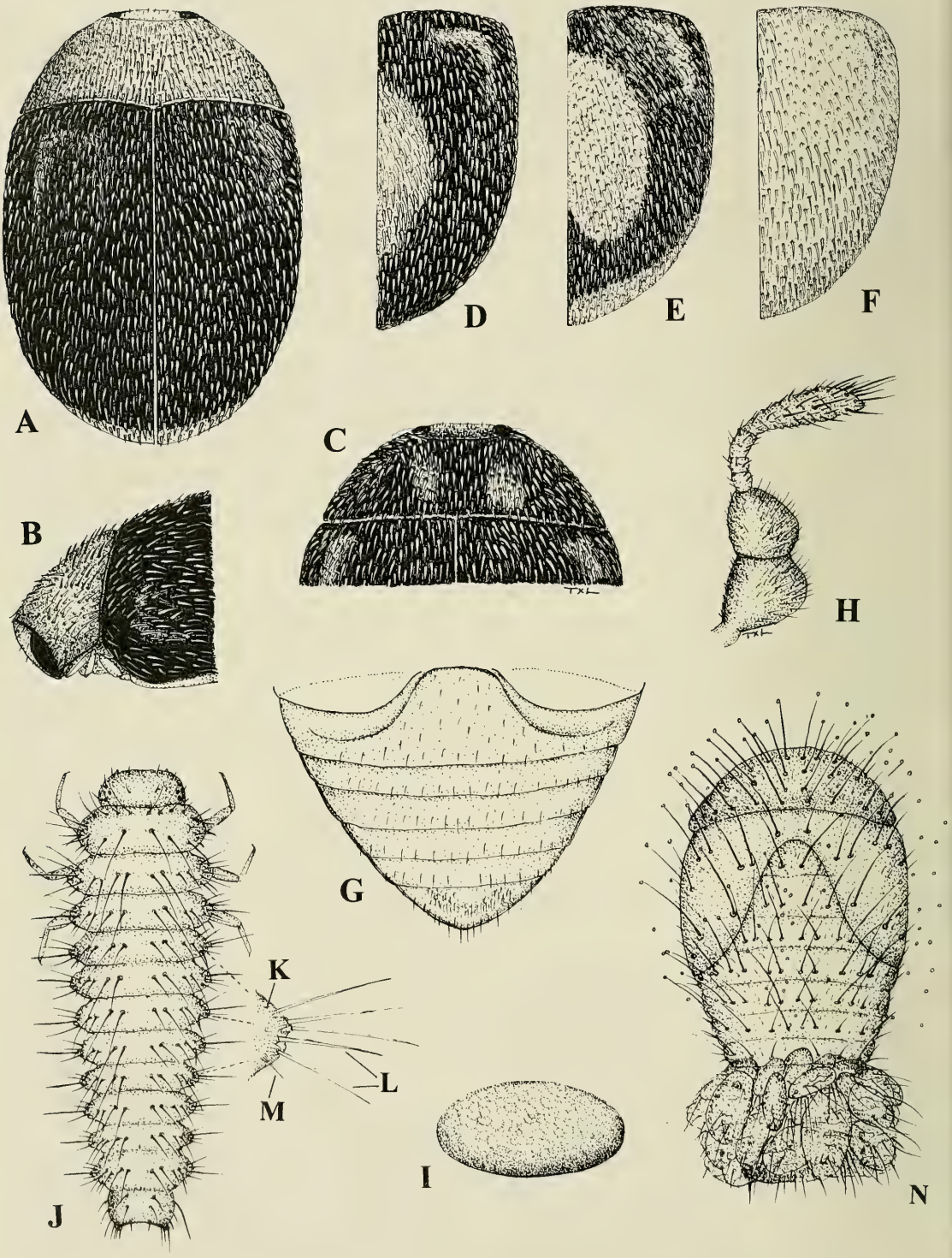

Fig. 1. *Nephaspis oculatus* (Blatchley). A, Male; B, Lateral view of anterior part of male; C, Head and pronotum of female; D-F, Variation in male elytron; G, Abdominal sterna (6 segments); H, Antenna; I, Egg; J, Larva (third instar); K, Strumum with chalazae (L) and collar setae (M); N, Pupa.

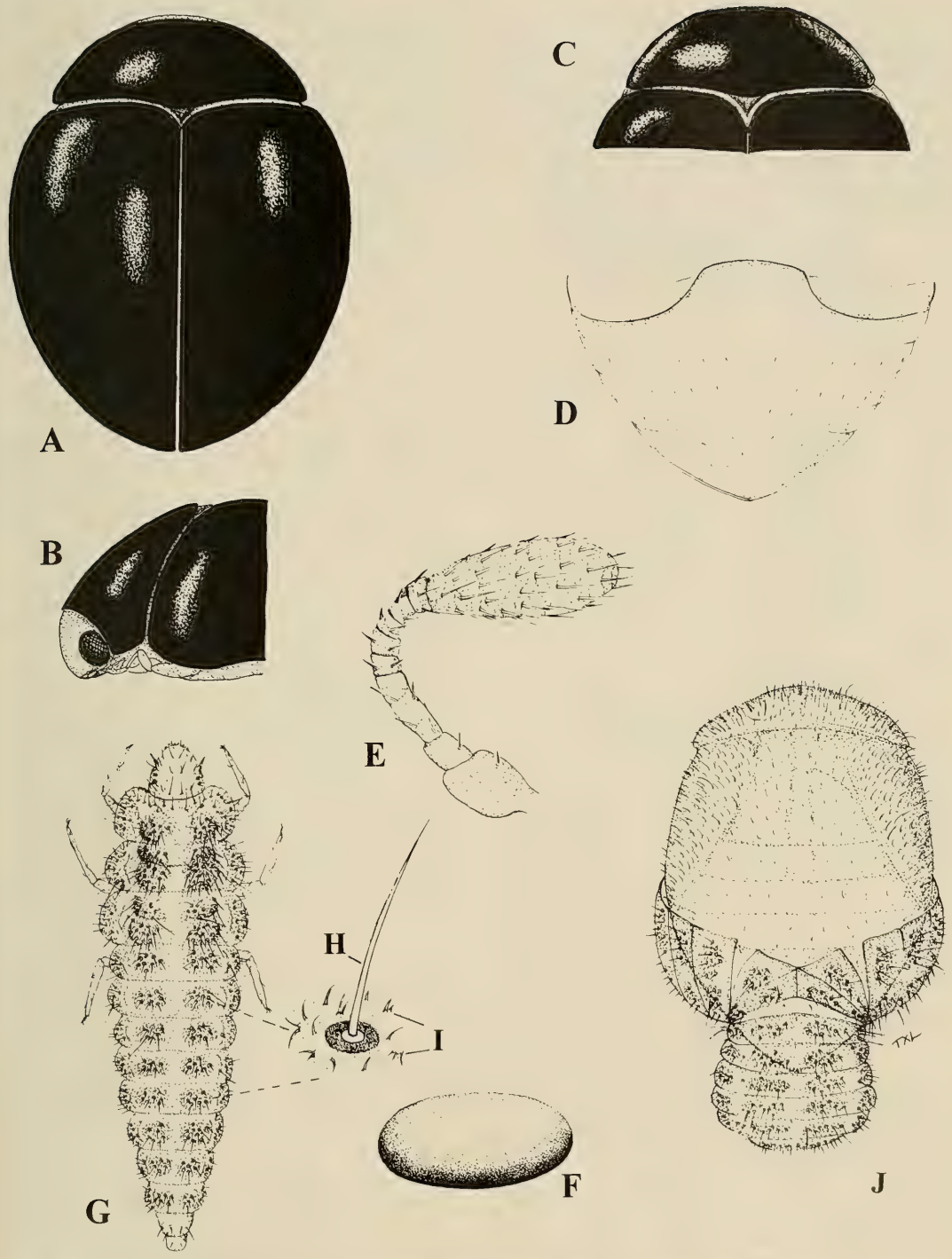

Fig. 2. *Delphastus pusillus* (LeConte). A, Female; B, Lateral view of anterior part of female; C, Pronotum and head of male; D, Abdominal sterna (5 segments); E, Antenna; G, Larva (third instar); F, Egg; H, Seta with a circular brown or dark area at base; I, Asperities: J, Pupa.

ter eclosion. All measurements (given in millimeters) are means followed by range and standard error in parentheses. Correlation between the body length and head (capsule) width for larvae was analyzed using the PROC CORR procedure (SAS Institute 1988).

Results and Discussion

Nephaspis oculatus (Blatchley) (Figs. 1, 3A, C, F, G)

Adult (Fig. 1A–G).—Body small, 1.26 (1.1–1.4, SE = 0.06) long, 0.87 (0.7–1.0, SE = 0.06) wide (N = 30), pubescent. Head visible when searching and feeding, invisible when at rest, with mouthparts directed posteroventrally (Fig. 1A–C), concealing prosternum; clypeus extending beyond eyes. Postcoxal line incomplete, curved from base medially and forward toward base of sternum laterally, abdomen with 6 sternal segments visible (Fig. 1G). Sexes easily separated. *Female:* vertex of head and pronotum entirely black, elytron usually piceous to black along base and lateral margin, central area of posterior margin yellowish brown (Fig. 1C). *Male:* pronotum yellow (Fig. 1A, B), meso- and metasternum piceous to black; elytron varying from completely black (except apical yellow area), to black or piceous with red or yellowish distal spots of various sizes and shapes (small and round, or elongate) (Fig. 1C–F). *Antenna* (Fig. 1H): small, whitish yellow, scape 8-segmented, with club 3-segmented; two basal segments extremely large, last 6 segments with length shorter than width; all segments with slender setae and large sensorial hairs.

Egg (Fig. 1I).—Usually elongate oval, 0.41 (0.35–0.49, SE = 0.02) long, 0.18 (0.15–0.23, SE = 0.04) wide (N = 30), greenish to yellowish white; under magnification of 20× or more, chorion appearing reticulate except ventral surface. Reticulation becoming more distinct after eclosion. Eggs laid singly on leaf surface, often in conjunction with whitefly eggs.

Larva.—Elongate, fusiform, white, widest across metathorax (Fig. 1J). Morphological characters for each instar not distinctly different except body size. Head (Fig. 3A), broader than long, widest across ocelli; 3 ocelli laterally on each side of head; mandible apically simple; maxillary palpus 3-segmented, palpifer; 2–3 pairs of small collar setae located on front area above mouthparts. Antenna (Fig. 3F) 3-segmented; second segment longer and thinner than first, with a minute spinelike sensorial process, with many sensorial acute processes on terminal area, and 1 long hairlike process; third segment indistinct with a large, acute conical sensorial process. All body segments broader than long. Pronotum (Fig. 3A), with 2 pairs of elongate setae near anterior margin, 3 pairs along posterior margin, and 1 pair in the middle; 7–10 pairs of chalazae on dorsolateral areas of each side. Mesothorax narrower or as wide as metathorax; metanotum with 1 pair of elongate principal setae beside midline, and 1 pair on submedian area of each side; 8–12 chalazae on dorsolateral areas. Setae on metanotum similar to mesonotum. Abdominal terga I–VIII with strumae (Fig. 1K), each bearing small chalazae (Fig. 1L), 7–10, and few long, slender collar setae (Fig. 1M). Tergite of ninth segment (Fig. 3C) with posterior margin truncate to slightly emarginate; 2 pairs of elongate setae beside midline, 2 pairs along posterior margin; 4 pairs of chalazae on dorsolateral area of each side; 1 pair of collar setae at posterolateral area of each side. One extremely long chalaza on each side of metathorax to abdominal segments I-VIII. Legs moderately elongate with few setae; tibia lacking terminal setae (Fig. 3G).

Larval head (capsule) width and body length of each instar well correlated (R = 0.86, P = 0.0001) although head (capsule) width less variable than body length (Table 1).

Four distinct larval instars were identified. The neonate is greenish white, and with each molt the body becomes larger and

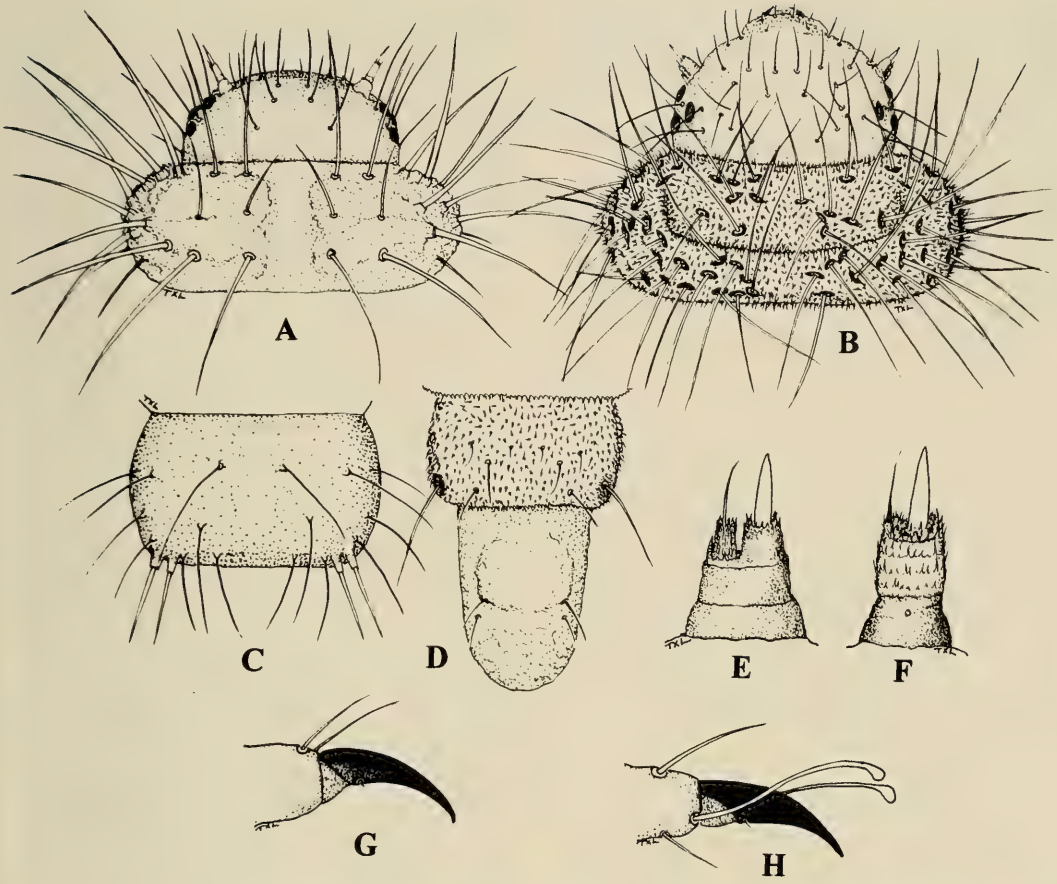

Fig. 3. Larval morphology of *N. oculatus* and *D. pusillus*. A, Head and pronotum of *N. oculatus*; B, Head and pronotum of *D. pusillus*; C, Abdominal segment IX of *N. oculatus*; D, Abdominal segment IX and uropod of *D. pusillus*; E, Antenna of *D. pusillus*; F, Antenna of *N. oculatus*; G, Tibia terminal and tarsal claw of *N. oculatus*; H, Tibia terminal and tarsal claw of *D. pusillus*.

Table 1. Body sizes of all stages of *Nephaspis oculatus* and *Delphastus pusillus*.

	Measurement (mm ± SE)					
	Nephaspis oculatus			*Delphastus pusillus*		
Stages	N	Length[a]	Width	N	Length	Width
Eggs	30	0.41 ± 0.02	0.18 ± 0.04	25	0.43 ± 0.01	0.23 ± 0.01
Larvae						
First instar	36	0.91 ± 0.08	0.16 ± 0.01	20	0.94 ± 0.05	0.17 ± 0.01
Second instar	20	1.43 ± 0.03	0.21 ± 0.01	20	1.52 ± 0.01	0.19 ± 0.01
Third instar	31	1.79 ± 0.04	0.26 ± 0.01	28	1.87 ± 0.01	0.25 ± 0.01
Fourth instar	27	2.37 ± 0.07	0.33 ± 0.01	27	2.83 ± 0.11	0.32 ± 0.01
Pupae	30	1.81 ± 0.74	1.02 ± 0.35	28	1.87 ± 0.01	1.08 ± 0.02
Adults	30	1.26 ± 0.06	0.87 ± 0.06	30	1.39 ± 0.07	1.09 ± 0.04

Correlation coefficients of head (capsule) width with body length for *Nephaspis oculatus*: $R = 0.87$, $P = 0.0001$; for *Delphastus pusillus*: $R = 0.98$, $P = 0.02$ (Proc Corr [SAS Institute 1988]).

whiter. Larvae move slowly when searching for prey, stopping frequently and moving the body from side to side using uropods on the caudal segment for process on the leaf surface. Debris often accumulates on the body including eggshells, wax and exuviae from whiteflies, and exuviae of the previous larval instar. Cannibalism among larvae and by adults on larvae was observed when prey were limited.

Pupa (Fig. 1N).—Newly formed pupa white, 1.81 (1.52–1.90, SE = 0.74) long, 1.02 (0.95–1.09, SE = 0.35) wide (N = 30), with long dark setae arranged as follows: 24–26 on head, 22–24 on thorax, 2 on abdominal segment I, 4 on II, 8 on III, and 12–14 on IV–VI with setae on VI weaker and thinner than on previous segments. A tiny, clear liquid droplet seen adhering to tip of each seta when relative humidity high. Pupal remains covered with whitefly debris attached at posterior end to previous (fourth) instar's exuvia.

Delphastus pusillus (LeConte)
(Figs. 2, 3B, D, E, H)

Adult (Fig. 2A–C).—Body small, 1.39 (1.2–1.6, SE = 0.07) long, 1.09 (1.0–1.2, SE = 0.04) wide (N = 30), hemispherical, oval or slightly elongate oval, black to dark brown, shiny with elytron slightly pubescent at base and apex; head, prosternum, and sterna somewhat lighter or yellowish; slightly pubescent; coarse punctures in a band across vertex; legs usually yellow; prosternum smooth, strongly lobed anteriorly, concealing mouthparts; head notched on each side for reception of antennae. Head normally visible dorsally, especially when feeding and searching for prey (Figs. 2A–C). Elytra appearing smooth, but with very fine sparse punctures, indistinctly pubescent at base and apex. Abdomen with 5 visible sterna (Fig. 2D); postcoxal line on first abdominal sternum incomplete, extending down posteriorly and nearly parallel to apical margin toward lateral margin (Fig. 2D). Sexes easily separated with the male having a brown head and lateral margin of pronotum yellow (Fig. 2C). *Antenna* (Fig. 2E): Nine-segmented, segments I and II short and stout, III long and thin, IV–VIII short with length equal to or shorter than width, and IX distinctly clubbed, enlarged apically; each segment with several slender and strong sensorial setae and sculpturelike wrinkles, setae and wrinkles dense on apical segment.

Egg (Fig. 2F).—White, elongate oval, smooth; 0.43 (0.38–0.46, SE = 0.01) long, 0.23 (0.20–0.25, SE = 0.01) wide (N = 25); laid singly or 2–4 together on leaf surface where whitefly eggs and nymphs are abundant.

Larva.—Body (Fig. 2G) pale whitish or pale yellowish white, fusiform, widest across metathorax, setiferous, weakly sclerotized without distinct sclerites. Head (Fig. 3B) elongate oval, widest through ocelli, gradually converging anteriorly; front suture incomplete, indistinct; approximately ⅔ to ¾ of width of anterior margin of prothorax; 3 ocelli on each side black; setae long and slender; mandible triangular, apically simple, curved, with molar area developed. Antenna (Fig. 3E), 3-segmented, distinct dorsally; second segment longer and thinner than first, anterior area with elevation bearing long, acute and slender sensorial process; third segment small, conical, terminating with several minute, acute sensorial papillae and a single, long acute sensorial process. Newly hatched first and second instars whitish pale, circular area at base of long seta slightly brown and indistinct; third and fourth instars with long setae, each with a brown or black circular area at base on each thoracic segment and abdominal segments I–VIII (Fig. 2H). All body segments rounded laterally, broader than long except for ninth (last) abdominal segment. Pronotum (Fig. 3B) with 2 clusters of principal setae rising from pigmented area (Figs. 2H, 3B) near anterior margin, 2 clusters near posterior margin beside midline, and 10–12 on dorsolateral area of each side. Meso- and metathorax each with 2 clusters

Table 2. Morphological comparison of *Nephaspis oculatus* and *Delphastus pusillus*.

Stages	*Nephaspis oculatus*	*Delphastus pusillus*
Adult-Female	Body brown; elytron piceous to black; yellowish hairs densely covering body and elytra	Body black or dark reddish; prosternum and legs yellow; shiny
Male	Pronotum, head, and prosternum whitish yellow; elytra completely black with apical area yellow, or black or piceous with red or yellow distal spot	Pronotum black, with lateral margin yellow; head brown
Mouthparts	Directed posteroventrally	Directed anteroventrally
Antennae	Segment I and II extremely large, club 3-segmented, slightly enlarged	Segments I and II larger than II–VI, club one segmented, extremely enlarged apically
Abdomen	Six abdominal sterna visible	Five abdominal sterna visible
Eggs	Reticulated	Smooth
Larvae	White; 7–8 pairs of dark slender setae on abdominal segments I–VIII; each segment with strumae each bearing small-based chalazae or collar setae; setae long; last segment (ninth) with posterior margin truncate to slightly emarginate	Pale yellow; densely covered with fine hairs and setae, and principal setae thin and long, a dark (brown or black) circular area at base; no strumae; asperities on submedian and lateral areas of each thoracic segment and segments I–VIII; last segment narrow, longer than width, conical
Pupae	White; setae dark and strong, often with a clear liquid droplet distally depending on humidity; exuviae of last instar larva covered with long setae and empty whitefly egg and nymphal shells attached to posterior end	Pale yellowish white; setae thin, more numerous on cephalic and thoracic regions, and sparse on abdomen. Exuviae of last instar larva attached at end but without empty whitefly egg or nymphal shells

of principal setae beside midline, and approximately 10–12 long setae on dorsolateral area of each side. Abdominal segments I–VIII successively narrower posteriorly, each with large brownish or dark brownish setiferous areas on submedian area on each side, containing 7–15 setae on dorsolateral area, and 6–16 on submedian area. Dorsolateral areas less setiferous than dorsal areas; pigmented spots at base of principal setae on dorsolateral and median areas lighter than those on submedian areas. Ninth abdominal segment (Fig. 3D) longer than wide, lightly pigmented area with 1 long seta located on posterolateral area on each side. Uropod present with 2 pairs of small setae in middle area (Fig. 3D). Asperities simple, double or triple (Fig. 2I), scattered on surface, more dorsolateral than submedian. Legs moderately long, slender, sparsely setiferous; two terminal setae of tibia distinct, capitate with terminal expansion abrupt and small, one located ventrolaterally on each side of claw (Fig. 3H). Larval head (capsule) width and body length for each instar were correlated ($R = 0.98$, $P = 0.02$, Table 1).

The majority of the larvae have four stadia, but occasionally a supernumery fifth instar occurs (Hoelmer et al. 1993).

Pupa (Fig. 2J).—Yellowish white or whitish grey; 1.87 (1.22–1.97, SE = 0.01) long, 1.08 (0.98–1.12, SE = 0.02) wide (N = 27). Cephalic region and thorax with numerous long slender and curved setae; abdominal segments with a few small slender setae. Abdomen with setiferous exuviae of fourth instar larva attached at posterior end covering 2–3 abdominal segments.

For convenience, the major morphological characters for each corresponding stadium for the two species are summarized and tabulated in Table 2.

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FIRST RECORD OF *OMYOMYMAR* (HYMENOPTERA: MYMARIDAE) FROM CHINA, WITH THE DESCRIPTIONS OF THREE NEW SPECIES

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Abstract.—The genus *Omyomymar* Schauff is recorded for the first time in the Old World and three new species, ***O. glabrum, O. longidigitum,*** and ***O. breve,*** are described from females collected in the Oriental Region at Fujian, China. The male of *O. glabrum* is also described, and a key to females is presented.

Key Words: Mymaridae, China, taxonomy, *Omyomymar*

Omyomymar Schauff is a small genus of Mymaridae (Schauff 1983) comprising only four described species from the New World: two described by Ogloblin (1935) and two by Schauff (1983).

A study of material collected from Fujian, China has revealed three new species belonging to this genus. This is the first published record of this genus from Old World.

The descriptions are based on specimens slide-mounted in Canada balsam. All measurements were taken from slide-mounted specimens at 200× and 400× magnification using a compound microscope and eyepiece reticle.

We follow Debauche (1948) and Schauff (1983) in using terms and making measurements. Measurements in parenthesis refer to holotypes. Body length is measured from the anterior of the head to the apex of the metasoma, excluding the exserted part of the ovipositor. The ovipositor is measured basally from the point at which the shaft curves inward to its apex. The abbreviation F stands for antennal funicle segment, OOL for the minimum distance between posterior ocellus and eye margin, and POL for the distance between posterior ocelli. The key to females of the genus is modified from Schauff (1983), to include the three new species.

The specimens of *Omyomymar* n. spp. studied are deposited in the collections of the following institutions:

BCRI Biological Control Research Institute, Fujian Agricultural University, Fuzhou, Fujian Province, China;

IEFA Istituto di Entomologia, Facolta' di Agraria, Piacenza, Italy.

Key to Females of *Omyomymar*

1. F4–F6 taken together clearly longer than club, by at least ⅓ of the latter (Fig. 1) [the exserted part of ovipositor at least 1.3× metasomal length, (Fig. 7)] . . . . . *glabrum,* new species
– F4–F6 taken together clearly shorter than club 2
2. F1 shorter than pedicel by about ⅓ of the latter (Fig. 2) [the exserted part of ovipositor less than 0.5× metasomal length, (Fig. 8)] . . . . . *breve,* new species
– F1 longer than pedicel 3
3. F6 wider than long, F5 quadrate [the exserted part of ovipositor less than 0.25× metasomal length] . . . . . *alar* Schauff
– F6 and F5 longer than wide (Fig. 3) 4

4. F1 at most 4× as long as wide . . . . . *clavatum* (Ogloblin)
– F1 at least 6× as long as wide (Fig. 3) 5
5. F4 as long as F5; club about 2× as long as wide; apical digit as long as wide; the exserted part of ovipositor at least metasomal length . . . . . *grisselli* Schauff
– F4 longer than F5; club 3× as long as wide; apical digit 2× as long as wide (Fig. 3); the exserted part of ovipositor less than metasomal length (Fig. 9) 6
6. Dorsal margin of F6 straight; the exserted part of ovipositor about 0.7× metasomal length . . . . . *silvanum* (Ogloblin)
– Dorsal margin of F6 excised (Fig. 3); the exserted part of ovipositor about 0.85× metasomal length . . . . . *longidigitum,* new species

Genus *Omyomymar* Schauff

Omyomymar Schauff 1983: 543–551; Schauff 1984: 44–45; Yoshimoto, 1990: 48.

The diagnostic characters of the genus reported by Schauff (1983) are: "tarsi 4-segmented, female antenna 10-segmented, funicle 6-segmented, club 2-segmented, the apical segment produced into a digit; male scape with several conical sensilla basiconica; posterior scutellum divided medially by a longitudinal sulcus; propodeum divided medially, phragma projecting to hindcoxae or beyond; gaster broadly attached to thorax, lightly sclerotized anteriorly, darkening posteriorly; ovipositor exerted past tip of abdomen. In a subseguent paper (1984) the same author adds in the diagnostic characters "forewing with two parallel lines of setae on basal half of membrane." In Yoshimoto (1990), the characters "male flagellum 11-segmented; scutellum broader than long; posterior scutellum subcrescentic" are added.

The Chinese specimens that we have studied fit Schauff's description of the genus and generally present all the diagnostic characters listed above except for the two longitudinal lines of cilia on basal half of disc past venation, that are not always parallel as Schauff (1984) and Yoshimoto (1990) specify (Fig. 5). Furthermore, in the holotype of *O. glabrum,* the digit of the club cannot be detected clearly but we think this could be due to the fact that, in this species, it is not very developed and the position of the club already stated masks its presence.

The excision in the dorsal margin of F5 and F6 can be clearly seen in the species *breve* and *longidigitum* whereas in *glabrum* the dorsal margin seems straight. In this case we cannot be sure of the state of this character as this could be due to the position of the antenna on the slide, as we have noted in a *longidigitum* paratype, and we possess only two specimens of this species.

Some other characters, not mentioned by the previous authors, were always present in the Chinese specimens: vertex more or less reticulate; radicle fused with the scape; female scape 4× as long as wide, no sensory ridges on female funicle segments; mesoscutum with two setae near notauli.

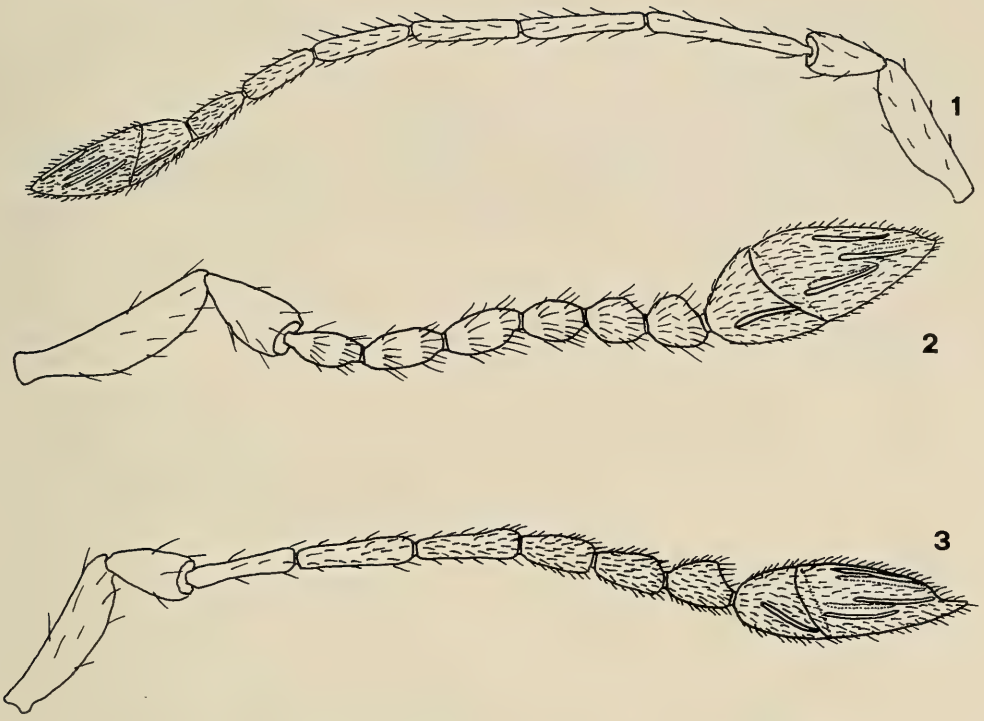
We have not studied any New World species and therefore we cannot add diagnostic characters that have not been specified in Schauff (1983). Nevertheless, some of the above listed features, that are present in all Chinese species, seem important to us and could represent diagnostic character, if verified in the American species too.

Omyomymar glabrum Lin and Chiappini, New Species

(Figs. 1, 4, 7)

Female: Length of body 0.75 mm (0.64–0.90). Body yellow, except funicle segments, club, mesopleura, propodeum and distal half (excluding tip) of metasoma, which are brown. Eyes red.

Head. POL 18, OOL 6. Antenna as in Fig. 1 with all funicle segments cylindrical. F5 and F6 more than 2× as long as wide. Club elongate elliptic, more than 3× as long as wide, without a distinct apical digit at the tip or with a very short one; its basal segment shorter than the apical one. Relative lengths of antennal segments from scape to club 40: 20: 40: 35: 29: 25: 22: 15: 45 (club width 13).



Figs. 1–3. Female antenna. 1, *Omyomyar glabrum.* 2, *O. breve.* 3, *O. longidigitum.*

Mesosoma a little shorter than metasoma (56:60). Reticulate sculpture faint on mesoscutum and scutellum, but distinct on postscutellum and propodeum. Forewing (Fig. 4) about 9× as long as wide (163:18); its longest marginal cilia about 1.9× its maximum width (34:18). Discal cilia irregularly scattered over apical ¼ wing blade, the anterior longitudinal line of cilia beginning beyond the end of venation. Hind wing almost as long as forewing (160:163), with one and a half lines discal cilia. Legs slender, ratio of femur: tibia: tarsus as follows: foreleg 63: 68: 77; midleg 63: 105: 85; hind leg 77: 142: 90. Fore tarsus with proximal segment as long as following one, distal segment the shortest.

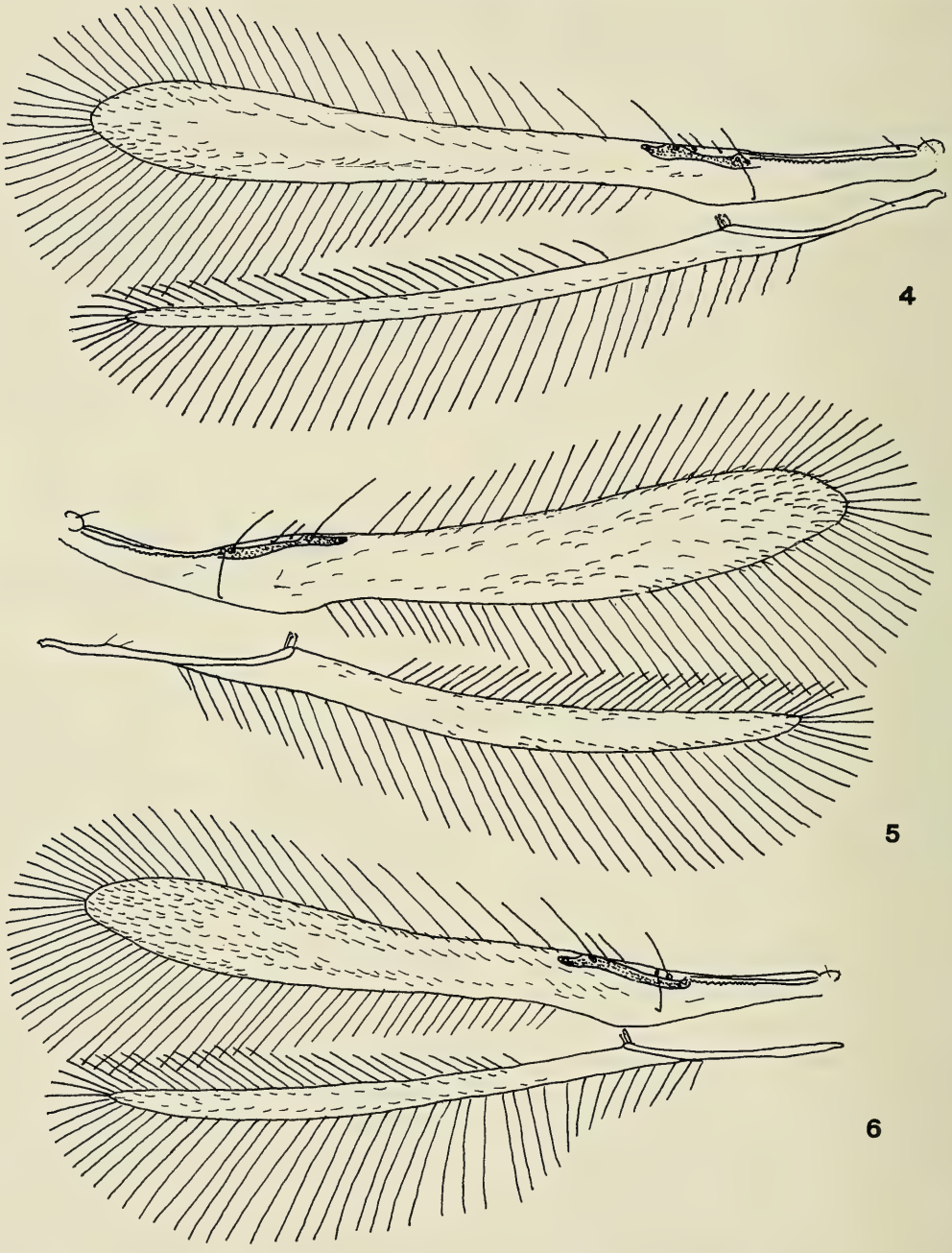
Metasoma. Ovipositor (Fig. 7), longer than body length (165:148), exserted beyond apex of metasoma by 1.4–1.5× metasoma length (90:60). Ovipositor/foretibia ratio about 4.7 (165:35).

Male: Length of body 0.64 mm. Body coloration brown except scape, pedicel, legs and proximal fourth of metasoma which are yellow-brown.

Relative lengths of antennal segments, beginning with scape 32: 19: 24: 23: 23: 23: 23: 22: 21: 20: 20: 20: 20 (Fig. 11). Each funicle segment with two to five sensory ridges.

Mesosoma. Forewing (Fig. 12) from 7.6 to 8.4× as long as wide; its longest marginal cilia about 2× its maximum width. Discal cilia irregularly scattered over apical fourth of wing blade, the anterior longitudinal line of cilia beginning beyond the distal end of venation.

Metasoma. Genitalia as in fig. 10 with "aedeagus encapsulated inside a sac-like phallobase" .. "with parameres and without volsellar digiti" as described by Viggiani (1988) for the Mymarinae in which he included *Omyomymar.* The phallobase has a small median ventral projection; the parameres are elongate, a little longer than foretibia (40:37), and sharp at apex. The aedeagus curves ventrally and its length, in-



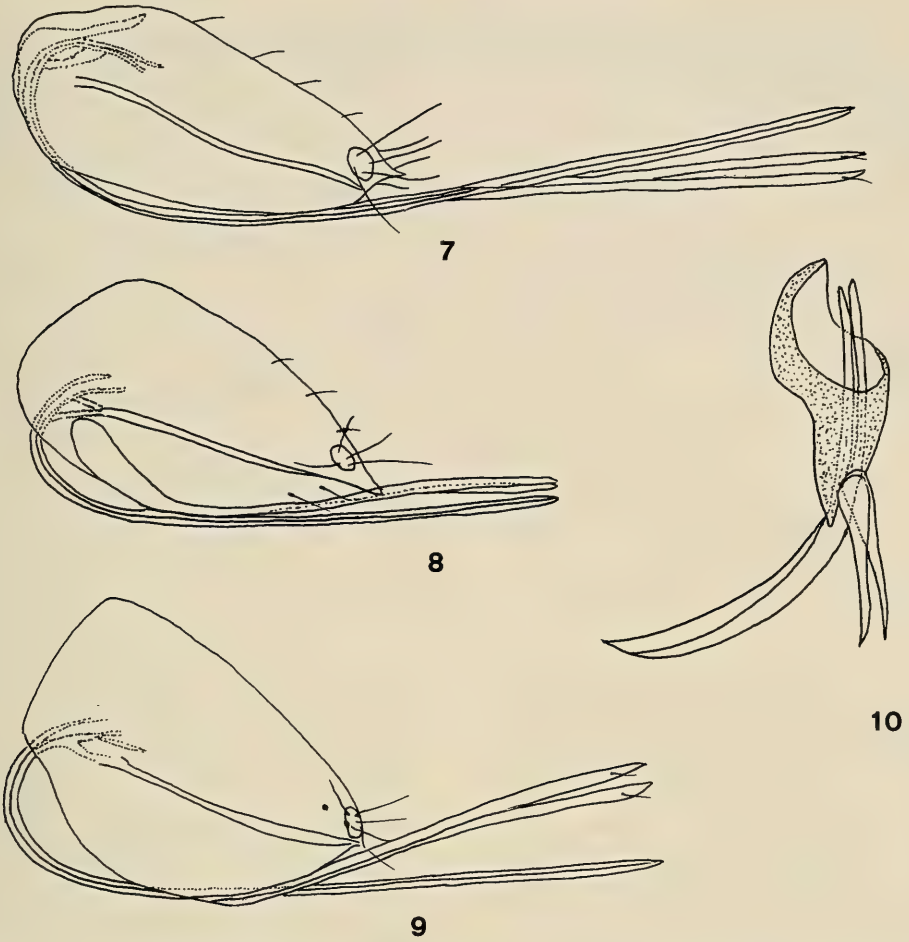
Figs. 4–6. Female forewing. 1, *Omyomyar glabrum.* 2, *O. breve.* 3, *O. longidigitum.*

cluding apodemes, is about 1.5× foretibial length (60:37).

Host: Unknown.

Type material.—Holotype female: Longxishan Nature Reserve, Jiangle County, Fujian, China, Oct. 10, 1991, Lin Naiquan, by sweeping. Deposited in BCRI. Paratype, 1 female: same data as holotype. Deposited in IEFA.

Other material studied.—2 males, Long-



Figs. 7–10. 7–9, Female metasoma. 7, *Omyomyar glabrum.* 8, *O. breve.* 9, *O. longidigitum.* 10, *O. glabrum,* male aedeagus.

xishan Nature Reserve, Jiangle County, Fujian, China, Oct. 10, 1991, Lin Naiquan collected by sweeping. Deposited in IEFA and BCRI.

Comments.—Males were collected by sweeping in the nature reserve of Longxishan at the same time of females; as the forewing shape and ciliation is almost the same, we think they belong to the same species. Nevertheless, as no biological data are available and we can rely only on morphology to assign males to the new species, we are hesitant to include them in the type series.

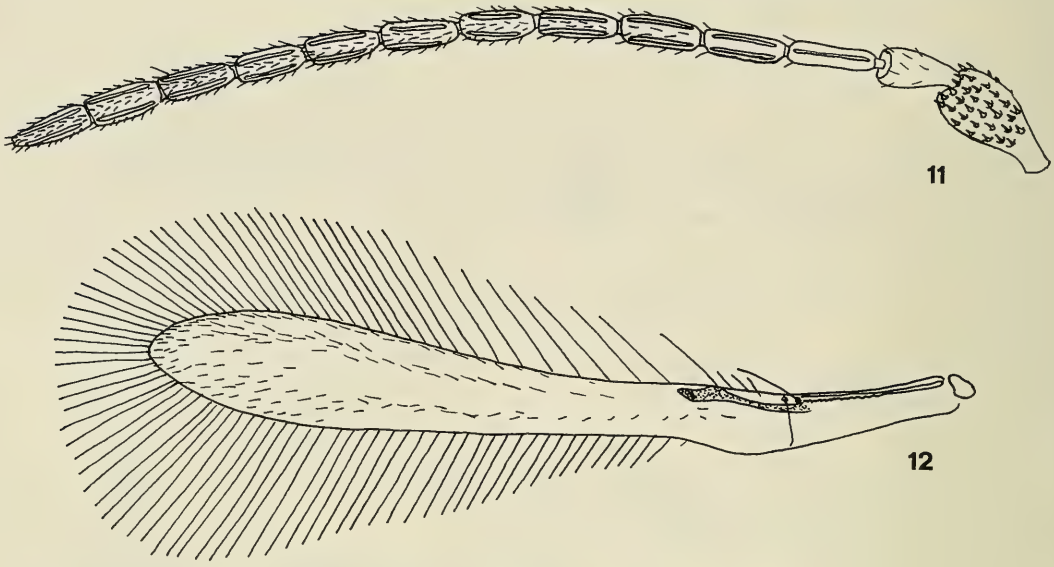
Diagnosis.—This is a very peculiar species the female being characterized by the short club and long ovipositor.

Etymology.—Latin adjective referring the few discal cilia present on the forewing.

Omyomymar breve Lin and Chiappini, New Species
(Figs. 2, 5, 8)

Female: Length of body 0.61 mm. Body yellow-brown, but funicle segments, club, propodeal pleura and distal half of metasoma dark yellow-brown. Legs, except hindcoxae, light yellow-brown. Eyes red.

Head. POL 20, OOL 8. Antenna as in Fig. 2, with funicle segments from F1 to F4



Figs. 11–12. *Omyomyar glabrum,* male. 11, Antenna. 12, Forewing.

subcylindrical, F5 and F6 with dorsal margins excised. F6 almost as long as wide (11: 10). Most of the setae arranged in two whorls on funicle segments. Club conical-ovate, with apical digit nearly as long as wide. Basal segment of club about half as long as apical. Relative lengths of antennal segments from scape to club 41: 19: 12: 15: 15: 11: 11: 11: 42 (club width 19).

Mesosoma about 0.9× length of metasoma (53:60). Forewing (Fig. 5) 7.8× as long as wide (124:16). Discal cilia randomly arranged on apical half of wing blade and the two longitudinal lines beginning at the end of venation. The longest marginal cilia about 2.3× wing blade's greatest width (37: 16). Hind wing slightly shorter than forewing (118:124), with 3 lines of discal cilia. Legs: ratio of femur: tibia: tarsus as follows: foreleg 46: 47: 35; midleg 50: 68: 46; hindleg 60: 87: 59. Fore tarsus with proximal segment the longest and two distal segments the shortest.

Metasoma: ovipositor (Fig. 8) about 0.55× as long as length of body (75:135), exserted beyond metasoma apex. The exserted part of ovipositor about 0.4× as long as metasoma (22:60) and as long as foretibia (22:23). Ovipositor/foretibia ratio about 3.2 (75:23).

Host: Unknown.

Type material.—Holotype female: Tongmu, Wuyishan Nature Reserve, Fujian, China, July 26, 1985; Lin Naiquan, by sweeping. Deposited in BCRI. Paratypes: 1 female: same data as holotype. Deposited in IEFA.

Diagnosis.—This species is a very peculiar one, being characterized by F1 clearly shorter than pedicel, flagellar setae mostly arranged in 2 whorls.

Etymology.—Latin adjective referring to the short funicular segments.

Omyomymar longidigitum Lin and Chiappini, New Species

(Figs. 3, 6, 9)

Female: Length of body 0.68 mm (0.62–0.77). Body brown except for scape, pedicel, legs, basal half and tip of metasoma, which are yellow. Eyes red.

Head. POL 20, OOL 9. Antenna as in fig. 3, with funicle segments from F1 to F4 cylindrical, more than 2× as long as wide. F5 and F6 excised dorsally, less than 1.9× as long as wide. Club about 3× as long as

wide with apical digit well developed, about 2× as long as wide. Basal segment of club much shorter than apical segment, about ½ length of the latter. Relative lengths of antennal segments from scape to club 40: 20: 27: 24: 21: 16: 15: 14: 50 (club width 17).

Mesosoma a little shorter than metasoma (60:70). Forewing (Fig. 6) about 8.5× as long as wide (144:17); its longest marginal cilia about 2× (32:17) its maximum width. Discal cilia randomly distributed on distal third of wing blade; the anterior line of cilia beginning behind the middle of venation. Hindwing almost as long as forewing (142: 144), with nearly two lines of discal cilia. Legs slender, ratio of femur: tibia: tarsus as follows: foreleg 58: 62: 72; midleg 60: 100: 74; hindleg 72: 120: 80. Fore tarsus with proximal segment almost as long as following one, distal segment the shortest.

Metasoma: ovipositor (Fig. 9) about 0.9× as long as body length (138:150), exserted far beyond metasoma apex. The exserted part of ovipositor just a little shorter than metasoma (60:70). Ovipositor/foretibia ratio about 4.6 (138:30).

Host: unknown.

Type material.—Holotype female: Longxishan Nature Reserve, Jiangle County, Fujian, China, Oct. 10, 1991. Lin Naiquan, by sweeping. Deposited in BCRI. Paratypes: 4 females: same data as holotype. Deposited in IEFA (2) and BCRI (2).

Diagnosis.—*Omyomymar longidigitum* resembles very much *O. silvanum,* but can be distinguished from the latter by the dorsal margin of F5 and F6 that is clearly excised in our species whereas Schauff stated that it is not in Ogloblin's species.

Etymology.—Latin noun referring to the long digit on the club.

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A NEW SPECIES OF *DISTATRIX* (HYMENOPTERA: BRACONIDAE) FROM CALIFORNIA, WITH BIOLOGICAL NOTES

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Abstract.—The first recorded species of *Distatrix* Mason from North America, ***D. solanae*** Whitfield, n. sp., is described from specimens reared in California from larvae of three species of geometrid moths. Biological information, and diagnostic characters distinguishing the new species from the other described species of *Distatrix,* are provided.

Key Words: Description, parasitoid, Lepidoptera, chaparral, oak woodland

An unusual, partly xanthic, species of microgastrine braconid wasp with enlarged eyes was reared by the junior author that appears unlike anything previously recorded in the Nearctic Region. The species belongs to the genus *Distatrix* Mason, which has no described species previously recorded in North America (Whitfield, 1995), although one described species has been recorded from southern Mexico. The genus will key with some difficulty to *Glyptapanteles* or *Venanides* in Marsh et al. (1987) but will not match the illustrations provided there.

The genus *Distatrix* was erected by Mason (1981) to include those species of *Apanteles* Foerster placed by Nixon (1965) in his *formosus* - group. The genus is relatively small, with less than 15 described species worldwide, most of which are found in the Old World. The New World species have never been revised. The new species shares with the other described species of *Distratrix* a number of features, including: absence of the upper pronotal groove; vannal lobe of hindwing subapically straight to concave, with reduced fringe of hairs; ovipositor sheaths with reduced, minute apical hairs, and the more or less triangular form of the second metasomal tergum. In addition, it shares with the European *D. formosus* (Wesmael) the habit of making unusual (for microgastrines) pedunculate (stalked) cocoons attached to the host plant of its geometrid host caterpillar.

Below we provide several biological details on the new species, and the senior author provides a description of its morphology. Terminology follows Mason (1981) for body structures, and Sharkey (1994) for wing veins.

Specimens of *Distatrix solanae* n. sp. were collected in three communities in California and Oregon during a survey of caterpillars and their parasitoids. Most *D. solanae* were collected in a chaparral and oak woodland community in the Vaca Mountains of California's inner Coast Range. At this site more than 7000 macrolepidopteran caterpillars (103 species in 10 families) were collected from the twelve most common trees and shrubs. The only host of *D. solanae* in the Vaca Mountains was *Prochoerodes truxaliata* (Guenee) (Geometridae), collected on *Baccharis pilularis* de Candolle. This geometrid is a specialist on

Baccharis (Ehler et al. 1990). Seventy-five second and third instar caterpillars (<20 mm) produced fourteen parasitoid pupae and twelve adults. More than 4000 additional caterpillars of various species were also collected from other chaparral and oak woodland sites where *Baccharis* or *P. truxaliata* are known to occur. However, it is unknown whether *D. solanae* occurred at these sites since *P. truxaliata* caterpillars were not collected.

The other two communities where *D. solanae* was collected were sampled less intensively. Three *D. solanae* were collected on the west slope of the Oregon Cascade Mountains on *Alnus sinuata* (Regal) Rydb., at a site dominated by *Tsuga heterophylla* (Ref.) Sarg. and *Pseudotsuga menziesii* (Mirbel) in the H. J. Andrews Experimental Forest. The parasitoids emerged from two *Elpiste lorquinaria* (Guenee) and an unidentified species in the Noctuidae. A single *D. solanae* was also found in the western Sierra Nevada Mountains of California at a site dominated by *Pinus ponderosa* Dougl. The parasitoid emerged from one of the two *Eupithecia* sp. (Geometridae) specimens collected on *Calocedrus decurrens* (Torr.) Florin. This host is from the *palpata* (Packard) species group (D. C. Ferguson, pers. comm.) but is not currently placeable to species.

Overall, *D. solanae* is a generalist, yet it is possible that populations are locally specialized on different host plants. The site with the strongest support for local specialization is the Vaca Mountains where *D. solanae* has either a strong preference for *P. truxaliata* or its host plant, *Baccharis*. *Baccharis* was one of the least abundant plants that was surveyed in the Vaca Mountains (Scaccia, unpublished data), yet 18.7 percent of the *Baccharis* specialist, *P. truxaliata,* were parasitized. Alternatively, the apparent host specialization of the Vaca Mountains population may be an artifact of sampling. More extensive sampling may reveal that species absent or under-represented in this survey are hosts of *D. solanae.*

Distatrix solanae probably attacks early instar caterpillars. Hosts ranged from 9–20 mm in length at collection. This length corresponds with second through late third instars for *P. truxaliata.* This size range may include final instar *Eupethicia lorquinaria* or *E.* sp. However, only *P. truxaliata* caterpillars were closely examined to determine the host stage at collection and parasitoid pupation.

The head capsules of several *P. truxaliata* caterpillars were saved after each molt. Head capsules of parasitized caterpillars were compared with unparasitized caterpillars to determine the instar at collection and parasitoid pupation. Head-capsule widths ranged from 1.41 to 1.58 mm for third instar caterpillars. This variation was greater than previously shown (Ehler et al. 1990) and may be due to differences in food quality, temperature, or sites.

Parasitoids emerged and pupated when host *P. truxaliata* caterpillars were in their third and fourth instars (possibly the final instar for *Elpiste* and *Eupithecia*). Eighty-three percent of the parasitoids from February and March collections emerged from fourth instar *P. truxaliata,* whereas seventy-five percent of the June parasitoids emerged from third instars. Parasitoid larvae typically emerged dorsolaterally from either side of the caterpillar, slightly anterior to the fifth abdominal spiracle. One parasitoid exited between the host's dorsal setae. Parasitoids spun their cocoons on stems or other host plant material (Fig. 4). Caterpillars were usually found moribund on the bottom of rearing containers when parasitoid pupation occurred. The pupal period lasted from eight to sixteen days depending on season. Two thirds of the adults were females.

Distatrix solanae is apparently multivoltine. In the Vaca Mountains, parasitized caterpillars were collected in February, March, June and July 1992. Adult *P. truxaliata* have also been collected in other months (J. DeBenedictis, personal communication). It is likely that *D. solanae* will also occur dur-

ing these other periods since none of the pupae underwent diapause.

Distatrix solanae Whitfield, New Species
(Figs. 1–5)

Holotype female.—Body length 3.2 mm; forewing length 3.6 mm.

Head (Fig. 3): Black except honey-orange palpi, scapes, pedicels, labrum, mandibles, palpi, and dark brown flagellomeres. Frons medially taller than broad due to size of eyes, weakly punctate; inner margins of eyes very weakly converging towards clypeus before diverging ventrally. Eyes extremely large, forming most of visible portions of head in lateral view (Fig. 3). Antennae slightly longer than forewing and tapering gradually; all but distal flagellomeres with 2 ranks of placodes; flagellomere 2 3.7× as long as broad; flagellomere 14 3.8× as long as broad.

Mesosoma: Honey-orange except darker regions around extreme ventral and dorsal portions of mesopleuron and anterodorsal corner of metapleuron, lateral regions of metanotum, and central portion of propodeum. Pronotum with dorsal groove essentially obliterated. Mesoscutum evenly, sparsely and shallowly punctate, less distinctly so posteriorly; surface otherwise rather polished; width just anterior to tegulae just barely less than that of head. Scutoscutellar scrobe composed of an indeterminate number of confluent crenulations, weakly arched medially. Scutellar disc slightly longer than anteriorly broad, distinctly but shallowly punctate. Metanotum weakly and evenly retracted from scutellum; sublateral setiferous lobes not developed. Propodeum (Fig. 1) mostly weakly punctate to smooth, evenly convex medially, with short superimposed ridges posteriorly, radiating from nucha.

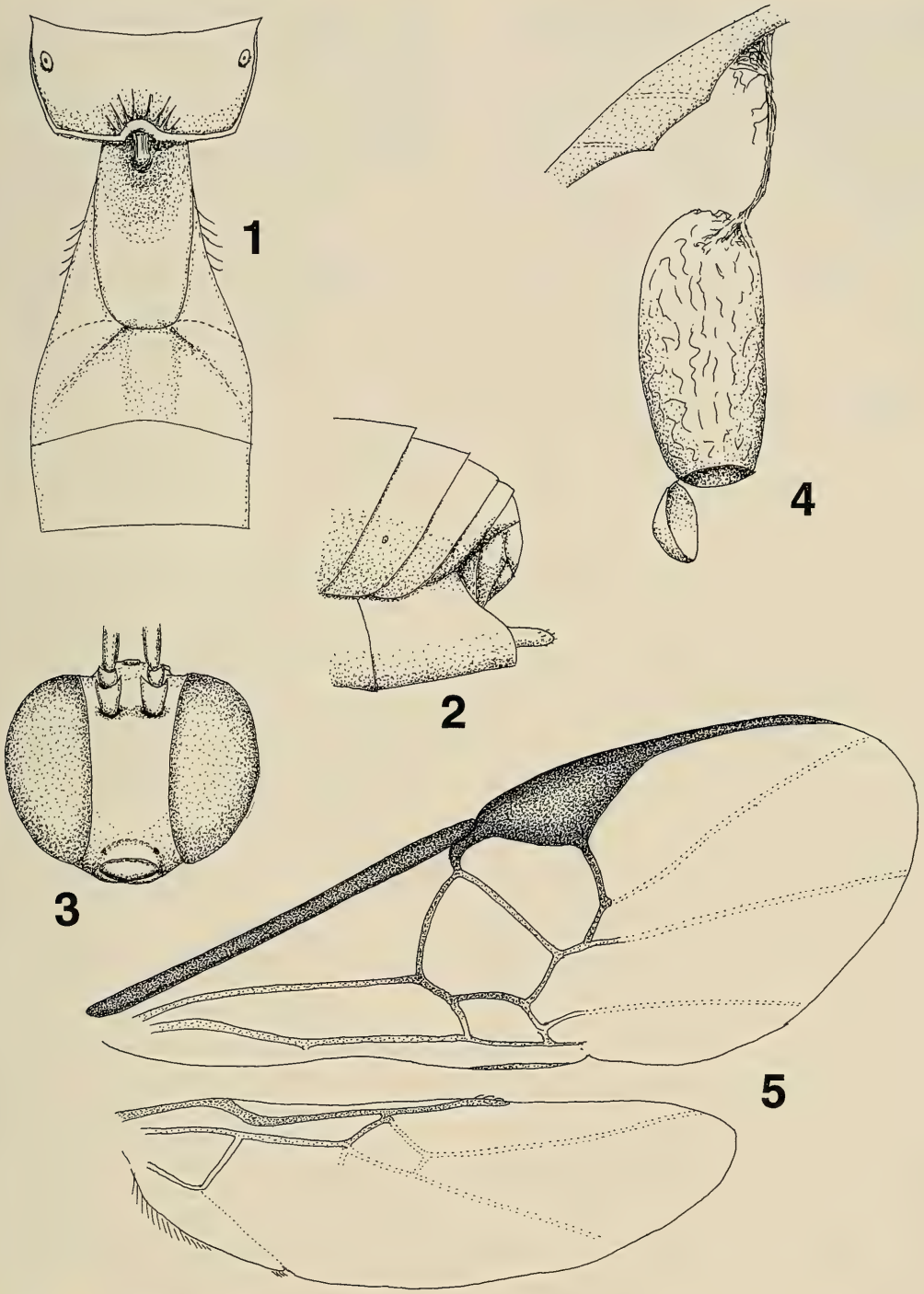
Legs: Pale honey-orange except distal tarsomeres (pro- and mesothoracic legs) and apices of femora and tibiae and most of tarsi (metathoracic legs). Hind coxae long, extending to just beyond posterior margin of third metasomal tergum. 25-30 spines on outer faces of hind tibiae, subequal in length with normal setae but thicker and pale golden. Inner apical spurs of hind tibiae 1.2× as long as outer, about 0.7× length of hind basitarsus.

Wings (Fig. 5): Hyaline, proximal venation of forewing even brownish, distal venation and stigma more darkly pigmented. Tegulae honey-orange. 2r of forewing weakly arched, somewhat longer than 2 + 3RS, meeting it at distinct but not acute angle marked by a knob. R1 1.1× as long as stigma, approximately 4× as long as distance from its distal end to end of 4RSb fold along wing edge. Stigma about 2× as long as broad, evenly pigmented (but pale at extreme base in some specimens). Hindwing with vannal lobe flattened subapically, with reduced fringe over flattened portion.

Metasoma (Figs. 1, 2): Honey-orange except darkened posterodorsal tip (medial regions of posterior terga), slightly darkened portions of hypopygium and nearly black ovipositor sheaths. Tergite I very weakly sculptured, 1.9× as long as broad at broadest point, subparallel-sided to narrowing posteriorly then rounding at posterior end, with broad excavation medially over anterior half; moderately arched in profile. Tergite II also weakly sculptured, subtriangular, 2.0× broader posteriorly than maximum length, shortest medially, with weakly concave posterior margin; surface raised medially; lateral margins of main tergite weakly defined. Tergite III and posterior terga of normal, unsculptured, overlapping form. Hypopygium (Fig. 2) relatively short, evenly sclerotized, truncate at tip. Ovipositor sheaths short and evenly tapering towards blunt tip, armed with sparse tiny setae at extreme apex. Ovipositor short, weakly decurved.

Males.—Mesosoma and metasoma mostly blackish, antennae more clearly longer than forewing. Eyes of more normal microgastrine proportions, with genae and postgenae clearly visible in lateral view.

Variation.—Some degree of variation (apart from the sexual dimorphism already



Figs. 1–5. *Distatrix solanae,* n. sp. 1, Dorsal view of propodeum and anterior three terga of metasoma. 2, Lateral view of apex of female metasoma. 3, Anterior view of female head. 4, Cocoon. 5, Wings.

noted) exists in the available series in the size of the darkened regions of the meso- and metasoma, sometimes extending to nearly all of of the mesopleuron, metanotum, metapleuron and propodeum. Body length 3.4–3.9 mm (females tend towards larger end of range). Forewing length 3.9–4.4 mm.

Cocoons (Fig. 4).—Brownish tan, rather tough, surface rather coarsely woven and attached by an asymmetrical silken stalk at one end to a host plant stem, leaf, or other substrate.

Material examined.—Holotype female: CALIFORNIA: Napa Co., 13 mi. W. Winters, 18-VI-1992, B. Scaccia, Bacc (92)228, pup. 17-VII-1992, em. 27-VII-1992, ex *Baccharis pilularis* DC (Univ. California, Davis). Paratypes: 1 female, similar data except emergence and pupation dates (JBW collection); 2 females, similar data but 12 mi. W. Winters, 17-II-1992 (Univ. California, Davis); 1 female, similar data but 14 mi. W. Winters, 8-III-1992 (Univ. California, Davis); 1 female, 1 male, Solano Co., Stebbins-Cold Canyon Reserve, 10 mi. W. Winters, 6-VII-1992, B. Scaccia (lot numbers and emergence dates vary) (B. Scaccia collection, Univ. California, Davis); 1 male, 1 female, similar data but 8-II-1992 (JBW collection); 1 male, similar data but 11-III-1992 (Univ. California, Davis). Holotype and paratype deposition locations listed after specimens; all specimens originally from B. Scaccia collection.

Hosts.—Three of the four hosts have been determined, all in the Geometridae. They are *Prochoerodes truxaliata* (Guenee) on *Baccharis pliularis* D. C., *Elpiste lorquinaria* (Guenee) on *Alnus sinuata* (Regal) Rydb., and *Eupithecia* sp. on *Calocedrus decurrens* (Torr.) Florin.

Comments.—This species most closely resembles *Distatrix teapae* (Nixon), both in morphology and coloration, sharing with it and *D. belliger* (Wilkinson) the enlarged eyes (females only at least in *D. solanae*). With *D. teapae* and at least two other *Distatrix* spp., *D. maia* (Nixon) and *D. formosus* (Wesmael) (but not *D. belliger*), it shares a modified distal front tarsomere, which is excavated apically on the ventral side and bears a strong curved spine over this excavation.

The new species differs from *D. teapae,* in having 2r of the forewing conspicuously longer than 2 + 3RS and meeting it at a distinct angle (often armed with a small knob), whereas in *D. teapae* 2r is usually shorter than 2 + 3RS and meets it in a gentle curve. In addition, the hypopygium of the new species (Fig. 2) appears more truncate apically than that of *D. teapae,* the mesonotum tends to be conspicuously longer than broad (in *D. teapae* the width and length are more or less equal) and the head tends to be smaller in comparison with the mesosoma. In general the dark brown areas of the body tend to be more extensive in the new species, but this is quite variable and might be geographically highly variable in both species. The confinement of the enlarged eyes to females is curious; that and the partly xanthic coloration would suggest that host searching may be nocturnal. Palmer and Tilden (1987) found that first instar *P. truxaliata* feed day and night, whereas later instars are nocturnally active. All caterpillar samples from which this parasitoid species emerged were collected at dusk, consistent with a crepuscular to nocturnal host searching period for *D. solanae.*

Acknowledgments

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in rearing caterpillars, D. C. Ferguson (Systematic Entomology Laboratory, USDA, Washington, D.C.) for identifying the *Eupithecia* species, W. Stein for use of equipment, N. Mills for assistance in sorting parasitoids, and J. DeBenedictis for sharing unpublished data on the hosts.

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SYNONYMIC NOTES ON *MACROCONDYLA* (*MACROCONDYLA*) *FLAVINERVIS* (MACQUART), 1846 (DIPTERA: BOMBYLIIDAE: LOMATIINAE)

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Abstract.—Based on study of type specimens, *Ulosometa falcata* Hull, 1973 is a **new junior synonym** of *Macrocondyla* (*Macrocondyla*) *flavinervis* (Macquart), 1846, and *Ulosometa* Hull, 1973 is a **new junior synonym** of *Macrocondyla* Rondani, 1863. Notes and illustrations of the types are presented.

Key Words: Diptera, Bombyliidae, Lomatiinae, synonymic notes, Taxonomy

Macrocondyla (*Macrocondyla*) *flavinervis* was originally described by Macquart (1846:109) as *Exoprosopa flavinervis,* based on a specimen from Colombia. According to Painter and Painter (1974:102), four specimens from Bigot's collection, deposited at The Natural History Museum, London, U.K. constitute the type series, from which they chose a lectotype. A detailed description of this material with a wing illustration and comments was presented by them.

Our examination of the lectotype and three paralectotypes of *M.* (*M.*) *flavinervis* from Bigot's collection, and comparison of these with the type material of *Ulosometa falcata* Hull, 1973, showed that they are conspecific with *M.* (*M.*) *flavinervis. Ulosometa falcata* is the only known species included in *Ulosometa,* a genus erected by Hull (1973:359–361) who stated that "these flies are related to *Ylasoia* Speiser, 1920 and possibly to *Oncodosia* Edwards, 1934 but differ in the wing venation."

As stated by Evenhuis (1991:49), there is no reason for Hall's (1973:149) treatment of *Lyophlaeba* as a valid genus instead of *Macrocondyla,* based on page priority. The action to follow is from the first reviser (Edwards 1934:103), in which *Macrocondyla* is the genus with two recognized subgenera: *Macrocondyla* s.str. and *Lyophlaeba* Rondani, 1863. Because of the specific level synonymy noted below, *Ulosometa* Hull, 1973 = *Macrocondyla* Rondani, 1863, **new synonymy**.

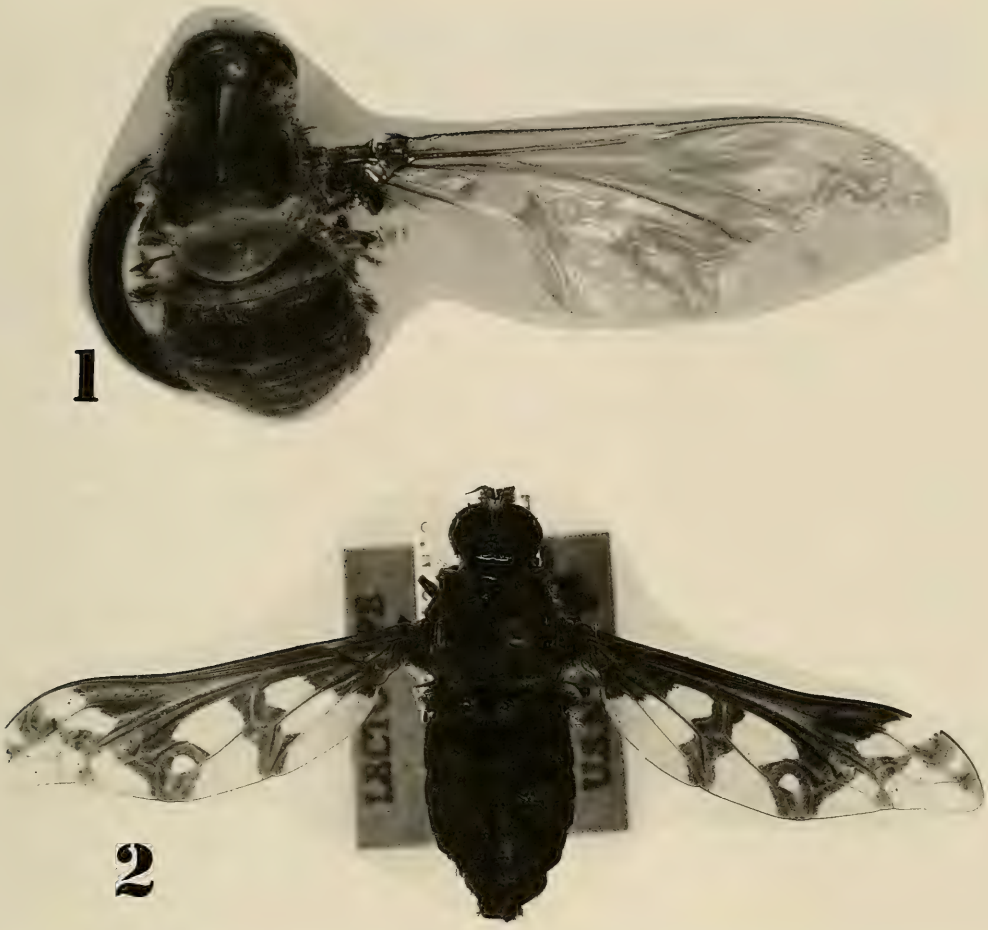
Macrocondyla (*Macrocondyla*) *flavinervis* (Macquart), New Combination

Exoprosopa flavinervis Macquart, 1846: 237.—Painter and Painter 1974: 101–105.

Lyophlaeba (*Macrocondyla*) *flavinervis:* Painter and Painter 1974: 101–105.—Painter et. al. 1978: 28.

Ulosometa falcata Hull 1973:359–361.—Painter et al. 1978: 29, **new synonym**.

Type material.—*Macrocondyla* (*M*). *flavinervis:* Lectotype. (Fig. 1) Female: Lectotype [white round label with dark blue margin]. Colombia. Colombia/ Coll. Fairmaire/ Ex. Bigot coll./ BM 1960-539. ex. = Ylasoia ?/ flavinervis/ Lectotype Mq./ 1960 det. R. H. Painter. Exoprosopa/ flavinervis/ Macq. N.sp. ♂♀ [glued on a larger label with the following data] Bresilia - Minas



Figs. 1–2. 1, Lectotype of *Macrocondyla (Macrocondyla) flavinervis.* 2, Paratype of *Ulosometa falcata.*

Gerais-nomm. par Macq.. Lectotype/ Exoprosopa/ flavinervis Macquart/ Det. J. E. Chainey, 1988. Deposited in The Natural History Museum, London, U.K. The specimen lacks the antennal flagellae, left wing, right front leg and both hind legs.

Specimens examined.—*Macrocondyla (M.) flavinervis.* Paralectotypes. Males: [All with the same labels]. Paralectotype [white round label with light blue margin]. Cotype [white circle label with yellow margin]. Colombia/ Coll. Fairmaire/ Ex Bigot coll./ BM 1960-539. Paralectotype/ Exoprosopa/ flavinervis Macquart/ Det. J. E. Chainey, 1988. Deposited in The Natural History Museum, London, U.K. One of them lacks all legs except the left foreleg, the antennae and right part of the head; another specimen lacks the head the other lacks the antennal flagellae.

Ulosometa falcata.—Holotype. Male: Tucuman/ V-7-1918. E. W. Rust,/ Collector. Est. Exp./ Agric./ n° 1686. Paralecto-/ type/ Ulosometa/ falcata/ Hull 1973 [red label]. Det./ N. Evenhuis/ 1991. [on the other side of the red label]. Deposited in United States National Museum. The specimen lacks the right antennal flagellum, and the left pedicel and flagellum. Right wing inside a plastic capsule and genital segments in glycerin in microvial.

Paratype (Fig. 2). Male: Tucuman/ V-7-1918. Frank M. Hull / Collection / C.N.C. 1981. Lectotype [red label] / Ulosometa /

falcata / Hull 1973 / U.S.N.M.. Det / N. Evenhuis / 1991, [on the other side of the red label]. Deposited in United States National Museum. The specimen lacks the right flagellum and the hind pair of legs. The left wing is broken at its tip near the apex of marginal cell. There is also a cut in the axillary cell.

Other material examined.—ARGENTINA: Tucumán, 3 ♀, 07.May.1918, E. W. Rust (USNM). BRASIL: Minas Gerais: Poços de Caldas, Morro do Ferro, 1 ♀ and 1 ♂, 27.Jan.1965, 1 ♀, 30.Mar.1964, J. Becker, O. Roppa and O. Leoncini. (MNRJ); 1 ♂, 30.Apr.1966, O. Roppa and O. Leoncini. (MNRJ); 1 ♂, 22.Mar.1966, O. Roppa. (MNRJ).

Discussion.—Although Hull (1973:355) and Hall (1975:133) stated that all *Lyophlaeba* (here treated as *Macrocondyla*) have the metapleuron with tufts of pile, all material we have seen has the metapleuron bare. Since other characters like, "tuft of bristly hairs on the lower posterior corner of the pteropleuron," and "3 submarginal cells" (used in Hull's, 1973:306, generic key) are also present in the examined specimens, we see no reason to treat them as distinct species.

Acknowledgments

We are grateful to Dr. Neal Evenhuis (Bishop Museum, Honolulu) for the loan of type material of *U. falcata* and reviewing the manuscript, to Dr. J. Chainey (The Natural History Museum, London) for the loan of the type series of *M. (M). flavinervis,* and also to Dr. S. Fragoso (Embrapa, Rio de Janeiro) for the photographs.

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BIOLOGY AND HOST SPECIFICITY NOTES ON *STYPHLUS PENICILLUS* GYLLENHAL (COLEOPTERA: CURCULIONIDAE), EXAMINED AS A BIOLOGICAL CONTROL AGENT FOR *CRUPINA VULGARIS* IN THE UNITED STATES WITH REMARKS ON ITS HOST PLANT

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Abstract.—*Crupina vulgaris* Cassini appeared in the field in southern France (depending on rainfall) by late September, early April, and early and late May, respectively. Mines of the weevil were found on cotyledons three weeks after the appearance of seedlings during early October, and were present until early April of the following year. Eggs were deposited on the bases of cotyledons, under the epidermis, from late September to early October. There are three larval instars. Larvae kept at 6 to 18°C did not pupate but larvae kept at 15 to 28°C pupated, in the soil. Adults fed briefly during May and June before hiding under stones to estivate until early September to October, depending on weather conditions. To obtain an indication of the weevil's host range, various crop plants were grown in a field where *C. vulgaris* and *Styphlus penicillus* Gyllenhal occurred. Some, including artichoke, were attacked by *S. penicillus,* indicating that its host range is too broad to permit its use as biological control of *C. vulgaris.*

Key Words: *Styphlus penicillus, Crupina vulgaris,* weed, weevil, host range, biology

Crupina vulgaris Cassini is native to the Mediterranean region of Europe and has been reported from southern and eastern Europe, Turkey, the Middle East to Iran, Russia, and northern Africa (Bremer 1994). According to Couderc-Le Vaillant (1972), there are three species in the genus: *C. vulgaris* Cassini, *C. crupinastrum* (Moris) Arcangeli, and *C. intermedia* Brig et Cavill. The latter species is a hybrid between the first two; it is an agressive competitor and can replace its parent species (Couderc-Le Vaillant and Roché 1993). *Crupina* is in the same tribe as the knapweeds, *Centaurea diffusa* J. B. A. P. Monnet de la Marck, *C. maculosa* J. B. A. P. Monnet de la Marck and *C. solstitialis* L. (Asteraceae: Cynareae). While seeds may remain viable for up to 32 months, the majority germinate the first year (Prather et al. 1991).

In Russia, *C. vulgaris* is a weed in semiarid pastures. It was first discovered in the USA (Idaho) in 1968; it infests 63,500 acres in the Pacific northwest. Of these, 55,000 acres are rangelands of north central Idaho in the counties of Idaho, Lewis, and Clearwater. Washington State has an infestation of 480 acres in Chelan County. Oregon has an infestation of 8000 acres in Umatilla County, and California a 20-acre infestation in Sonoma County (Flanigan 1991). For Idaho, Belles et al. (1981) reported 8000 acres infested, while Callihan and Sanders (1994) reported 60,000 acres infested, an increase of 7.5 times in 13 years. There are indications of multiple introductions into the USA (Couderc-Le Vaillant and Roché 1993). Beside wind, water, and humans, deer, cows, horses, and pheas-

ants contribute to seed dispersal (Thill et al. 1986). Since it is not preferred by livestock, it has a competitive advantage and often replaces the native vegetation in annual grasslands similar to those invaded by yellow starthistle (Callihan and Sanders 1994). Prather et al. (1991) reported that no insect natural enemies or specific pathogens are available for biological control of this weed.

A project on biological control of *C. vulgaris* was started at the European Biological Control Laboratory, Montpellier, France, in 1992. Our survey in southern France showed that several natural enemies attack *C. vulgaris* in its homeland. One of these is *Styphlus penicillus* Gyllenhal (Coleoptera: Curculionidae). The adults of this weevil, which live under stones, moss, and in litter, were identified by E. Colonnelli, University of Rome, Italy. The larvae which mine the leaves were examined by N. J. Vandenberg, Systematic Entomology Laboratory (SEL), Washington, D.C., USA. This insect was reported on *Crepis* (*Barkhausia*) *taraxicifolia* D. C. (Asteraceae) and *Hedypnois polymorpha* (P. Hervé) (Asteraceae) in southern France and in Germany (Hoffman 1958). No report could be found in the literature indicating *C. vulgaris* as a host plant for *S. penicillus*. The species was considered as a potential biological control agent for *Crupina vulgaris* because it attacks the seedlings at a time when they are small and are more vulnerable to competition from other plants. A field test carried out during September to December 1994 was conducted to determine the weevil's degree of host specificity and thus, whether or not the species could be employed against *C. vulgaris* in the United States.

Material and Methods

Biology.—Field and laboratory observations provided data on the bionomics of *S. penicillus*. To determine the number of larval instars, monthly samples of infested leaves were collected from December 1993 to March 1994 at St. Jean de Cuculles, 15 km north of Montpellier, France. The larvae were dissected from their mines and their head capsules were measured.

Since it was difficult to collect a sufficient number of adults to be used for experiments, we tried various methods for rearing larvae to the adult stage. A sample of 120 rosettes, with at least one mine per plant, was collected at St. Jean de Cuculles on 9 December 1993. Thirty were dissected to determine the number of larvae present in the mines. The remaining 90 rosettes were planted in 45 pots of 10 cm diameter (2/pot). Another 30 infested rosettes were collected at the same site on 13 December 1993 and were planted in the same kind of pots as above (2/pot). There were four sets of 15 pots, with 30 infested rosettes in each set. Two of the sets were placed in screen cages, one outdoors and the other in an unheated greenhouse. The third set was placed in an incubator with 8 h light, 15–18°C and 16 h dark, 6–7°C (cool incubator). The fourth set was placed in an incubator with 16 h light, 25–28°C and 8 h dark, 15–18°C (warm incubator). The aim of the experiment was to determine how the larvae could be reared to adults, to determine their damage to the plants, and survival of larvae. The rosettes were checked 20 January and 23 February 1994 and the number of leaves destroyed by the larvae and the number of larvae present on the plants were recorded. Adults that emerged from each set were recorded. The experiment was continued until 15 June 1994.

Infested leaves were field collected during March and April, when the larvae were mature. These leaves were placed in petri dishes on a layer of moist plaster of Paris and kept in the laboratory for rearing adults. Fourteen infested leaves of *Crepis taraxicifolia* were collected on 24 March and kept on moist soil for rearing adults for identification. The behavior of the adults reared from the plants was studied in the laboratory. Seven adults reared from *C. vulgaris* were caged in a glass cylinder (21 cm diameter and 20 cm high). A layer of sand

and a few small stones were placed on the bottom of the cage. *Crupina* plants were offered to the adults for feeding or oviposition. The cage was kept in the laboratory under ambient temperature and the weevils were examined frequently. The food plants were replaced as needed and the old plants were checked for oviposition.

To determine the density of a *S. penicillus* population in the field and its damage to *C. vulgaris,* eight patches with 7 to 27 rosettes each were selected (116 rosettes in total) at Montferrier, north of Montpellier, on 21 September, 1993; (in fact, at the beginning of the experiment, 17 patches with 158 plants were chosen, but eleven of them were destroyed by a tree cutting machine on 22 February). Each patch was in a circle of one meter diameter. The plants were checked monthly until 6 April 1994, and new plants that appeared in the field, the number of plants infested with *S. penicillus* larva, the number of cotyledons or real leaves that were destroyed, and the number of dead plants were recorded.

Field test to determine host specificity.— Seeds of the following test species were planted on 18 August, 1994: *Cynara scolymus L.* (artichoke), *Carthamus tinctorius* L. (safflower), *Helianthus annuus* L., *Lactuca sativa* L., *Tagetes erecta* L., *Calendula officinalis* L., *Cirsium pitcheri* (Torr.), *Zinnia elegans* Jacquin, *Aster chinensis* Nees, *Gazania splendens* Henderson, *Cichorium intybus* L., and *Crepis rubra* L. The seedlings were transplanted into small pots (10 cm diameter) on 10 September. The test plants were planted in a field at St. Jean de Cuculles, where *S. penicillus* and its host *C. vulgaris* were common, on 28 September and 15 October. They were placed among wild *C. vulgaris* seedlings at distances of 20–30 cm. Eight patches at a distance of 2–5 m were selected depending on the number of wild *C. vulgaris* rosettes present (5–30 rosettes/patch) (Fig. 1). The center of each patch was marked with a meter long iron bar, and the whole area was fenced with a red plastic net. Five patches were fenced together as one plot and three other patches were fenced next to it at a distance of about 2.5 m. This resulted in two test plants of each of the 12 species being grown in each patch ($12 \times 2 \times 8 = 192$ plants). Seedlings of *C. vulgaris* had appeared in the field by September, 1994 and were common at this time. The objective of the test was to determine if *S. penicillus* would attack any of the test plants. All plants were checked visually for the presence of leaf miners (Fig. 1). Infested leaves were collected and examined under a stereomicroscope. Living larvae dissected from the mines were compared with the larvae of *S. penicillus* from *C. vulgaris* plants. Then they were preserved in alcohol and sent to SEL, Washington, D.C., for identification.

Result and Discussion

Biology.—*Crupina vulgaris* seedlings appeared in the field during the second half of September, depending on rainfall. The rosettes started bolting by 6 April, budding started by 10 May, and flowering by the end of May. Senescence started by the end of June and depended mainly on rainfall or soil moisture. *Styphlus penicillus* mines appeared in the cotyledons of *C. vulgaris* about four weeks after the seedlings appeared in the field. One to three larvae were found in infested cotyledons. After the larvae ate all of the leaf parenchyma, they moved to other cotyledons or leaves. During December to February there were larvae in different ages in their mines. The last larvae were found during early April.

The eggs were black, ovoid, 0.4 mm × 0.8 mm and were deposited under the epidermis of the lower side, near the bases of cotyledons. Normally, one egg (rarely two) was deposited at each oviposition site. The emerging larvae mined toward the tips of the cotyledons, feeding on the upper and lower parenchyma. Measurements of the head capsules of 73 larvae showed that there were three larval instars. The head capsule of the L1 larva was 0.3 × 0.4 mm ($n = 24$), L2 was 0.4 × 0.5 mm ($n = 29$),

Figs. 1, 2. 1, Field experiment in St. Jean de Cuculles. 2, Damage to *Crupina vulgaris* leaf by *Styphlus penicillus* larva.

Table 1. Survival and feeding damage of *Styphlus penicillus* larvae on *Crupina vulgaris,* kept under four different conditions.

	Number *Styphlus* Larvae	Number Cotyledons Eaten	Number Leaves Eaten*	Number Dead Plants
20 January				
Outdoors	45	38/52	27	4/30
Greenhouse	34	16/48	23	6/30
Cold Incubator	36	39/48	34	6/30
Warm Incubator	16	42/50	22	5/30
23 February				
Outdoors	31	All except 4	53	13/30
Greenhouse	20	All	71	6/30
Cold Incubator	28	All except 1	71	7/30**
Warm Incubator	7	All except 3	32	5/30

* Total number of leaves was not recorded.
** Three and two larvae were resting in their mines on dry cotyledons.

and L3 was 0.5 × 0.6 mm (n = 20). The larvae were yellowish to milky white, with a dark brown head. They damaged the *C. vulgaris* seedlings and rosettes considerably (Fig. 2).

Thirty-two larvae were found in the 30 field collected rosettes and examined on 9 December, 1993. Living larvae were found in 24 rosettes and eight of these had two larvae/plant. All of the larvae were found in the cotyledons, except two, which had left them and penetrated into the leaves.

The best larval survival was observed in the cage outdoors and in the cold incubator. The highest plant mortality was in the cage outdoors and the highest feeding damage was in the cage in the greenhouse and in the cold incubator (Table 1). Ten adults emerged from the 15 pots kept in the greenhouse (30 March to 15 May) and five from 15 pots kept in the warm incubator (16 February to 4 March). No adults emerged from the 15 pots kept in the cold incubator by 15 June, when the experiment was terminated. It seems that the larvae need high temperatures to break their diapause. Twenty of the plants in the cage kept outdoors were dead by 10 March (for unknown reasons) and no adults emerged from them by 25 March, when the plants were destroyed.

Two of the ten larvae collected on 16 April and placed on plaster of Paris in a petri dish enclosed themselves in two tunnels, made of small pieces of the plaster of Paris. Two adults emerged from these tunnels three weeks later. However, 13 other larvae collected on 22 April 1993 and placed in the same kind of petri dish, in an incubator at 15–25°C, remained in their mines until they died. Some of the larvae in mines placed on moist soil and kept in the laboratory pupated in the soil. The majority of them remained in their mines on dry leaves for several weeks until they died. Eleven larvae were observed resting in their mines on dry leaves of potted *C. vulgaris* plants for several weeks until they died (they did not move to the fresh leaves).

Six adults emerged on 7 April 1994 from the sample of *Crepis taraxicifolia.* These also were identified by E. Colonnelli as *S. penicillus.* There were some differences in the color of the larvae and shape of the mines in *Crupina* and *Crepis.* The larvae in *Crupina* leaves were yellowish, but those in *Crepis* were milky white. In *Crupina* leaves, the miners mainly fed on the green parenchyma, while in *Crepis* leaves they mainly fed along the mid rib.

We observed minor feeding by the adults caged on *Crupina vulgaris* plants. They were relatively inactive; no copulation nor

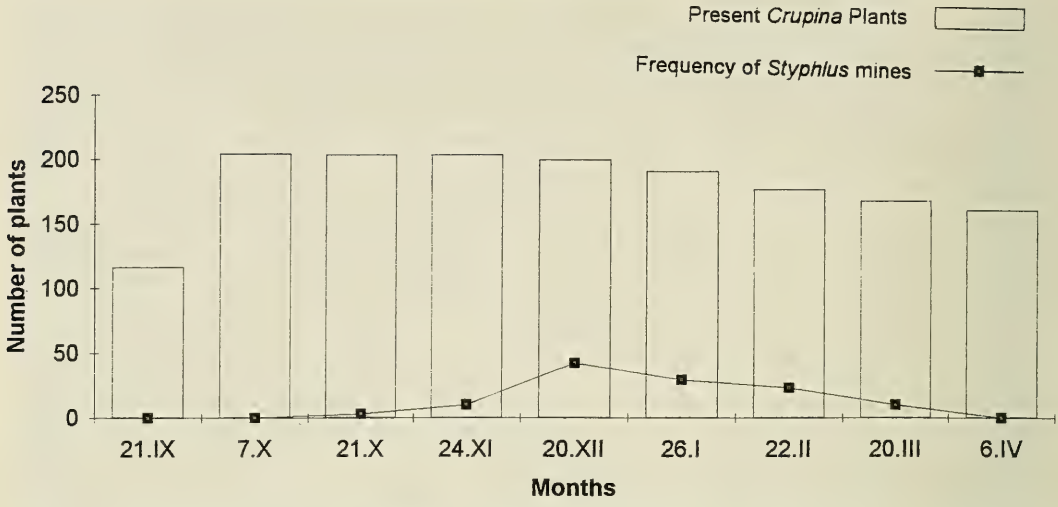

Fig. 3. Number of *Crupina vulgaris* plants and *Styphlus penicillus* mines on *Crupina* leaves in Montferrier during September 1993 to April 1994.

oviposition was observed. Five of the adults died during the period 12 April to 27 May 1994. The remaining two adults rested under stones until October 1994, when they started to feed on *Crupina* rosettes. The number of *C. vulgaris* seedlings increased from 116 on 21 September 1993, to 203 by 21 October 1993. Forty-three of these were dead by 6 April 1994 for unknown reasons. The plants were budding or flowering by mid May. Mines of *S. penicillus* appeared on cotyledons in October, increased during the second half of December, and decreased slowly until 6 April, when no more mines could be found on the plants (Fig. 3).

Field test to determine host specificity.— The first mine was observed on an artichoke leaf on 10 November 1994. Five more mines were found on artichoke leaves on 12 November. All of the mines contained living larvae, identical to *S. penicillus* larvae from *C. vulgaris*; D. M. Anderson and N. J. Vandenberg (SEL), who carefully examined these larvae and compared them with the *Styphlus penicillus* larvae, could not find any morphological differences between them. On 20 December, 1994, mines were also found on the leaves of the following test plants: *Cichorium intybus, Lactuca sativa, Crepis rubra, Cynara scolymus,* and *Carthamus tinctorius.* Examination of these mines showed the presence of *Styphlus penicillus* larvae which could not be reared to adults. Since feeding was seen on these plants, it was apparent that this weevil has a wide host range and could attack crop and economically important plants. At this point, testing was discontinued and consideration of *S. penicillus* as a control agent of *C. vulgaris* ended.

Several other promising natural enemies have been reared from *C. vulgaris* in southern France and are under study. These are a pathogen of seedlings, *Ramularia* n. sp.; *Aceria balasi* Farkas (Acarina: Eriophyidae) which attacks flower buds; *Clytie illunaris* Huebner (Lepidoptera: Noctuidae), a seed feeder; *Cochylini* sp. (Lepidoptera: Tortricidae), a defoliator; *Ornativalva plutelliformis* Staudinger (Lepidoptera: Gracillariidae), a seed feeder and *Metzneria aprilella* Herrich-Schäffer (Lepidoptera: Gelechiidae), a seed feeder.

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NEW SPECIES OF *PAUESIA* (HYMENOPTERA: BRACONIDAE: APHIDIINAE) PARASITOIDS ON *CINARA* (HOMOPTERA: APHIDIDAE: LACHNINAE) ASSOCIATED WITH CONIFERS IN THE PACIFIC NORTHWEST

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Abstract.—Three new aphid parasitoid species from Washington State are described and illustrated, and their key distinguishing features, host aphid and plant associations provided: ***Pauesia ahtanumensis*** n. sp. (host: *Cinara ponderosae* (Williams) on *Pinus ponderosa* Douglas); ***P. pahtonis*** n. sp. (host: *C. ponderosae* on *P. ponderosa*); and ***P. ponderosaecola*** n. sp. (host: *C. ponderosae* on *P. ponderosa*).

Key Words: Aphididae, *Cinara,* parasitoids, *Pauesia*

The genus *Pauesia* Quilis (Hymenoptera, Braconidae, Aphidiinae) includes parasitoids that attack aphids of several genera (*Cedrobium* Remaudière, *Cinara* Curtis, *Schizolachnus* Mordvilko, and *Tuberolachnus* Mordvilko) of the subfamily Lachninae. These lachnine aphids are associated mainly with conifers, but a few may be found on deciduous trees and shrubs.

Research on the aphid parasitoids attacking lachnines is much less extensive than that on aphids of agricultural importance, primarily because the lachnines have seldom reached pest status. Some exceptions have been where lachnines appeared as inadvertent introductions outside their native range and without their natural enemies. Parasitoids of the genus *Pauesia* have shown promise as introduced biological agents in several such cases. *Pauesia cedrobii* Starý and Leclant, a parasitoid native to the mountains of North Africa (Starý and Leclant 1977), introduced into France to control the cedar aphid, *Cedrobium laportei* Remaudière (Fabre and Rabasse 1987), was established in target areas and is now spreading inland within the country (Starý and Remaudière 1993). *Pauesia cinaravora* Marsh, a parasitoid native to George and Florida, introduced into South Africa to control *Cinara cronartii* Tissot and Pepper (accidental introduction from southeastern USA) (Kfir et al. 1985, Kfir and Kirsten 1991), was established as an effective agent. Other *Pauesia* spp. are currently being considered for use against *Cinara cupressi* (Buckton), a new, accidental introduction and threat to the forest and wood based industries of eastern and southern Africa (Kenya Forestry Res. Inst. 1991).

Information on *Pauesia* spp. in North America is limited to a review by Smith (1944), new species descriptions by Muesebeck (1958) and Marsh (1991), and a listing of the Nearctic American species North of Mexico (Marsh 1979). The present work provides descriptions of three new species reared from *Cinara* associated with conifers

in Washington State. Recognition of these parasitoids is fundamental to assessing their potential as natural control agents.

Material and Methods

Descriptions of taxa are based on both whole dry, and dissected slide-mounted specimens examined under microscope at 90 to 600x. Body lengths are measured and recorded in millimeters. Holotypes were dry-mounted on paper tabs and pinned. The descriptive terminology used is after Huber and Sharkey (1993).

Descriptions

Pauesia ahtanumensis Pike and Starý, New Species
(Figs. 1–15)

Diagnosis.—Following a key by Smith (1944), the new species keys to a group of species that show distinct and complete areola on the propodeum, and distinct additional carinae inside this areola. It can be distinguished from other species in the group by a 16–17 segmented antenna (female), smooth bicolorous mesonotum, perpendicular setae on both margins of the hind femur, apical setae with simple circular bases on the ovipositor sheath, and stigma coloration uniformly brown.

Etymology.—The name of the species is derived from its type locality, the Ahtanum Valley, Yakima Co., Washington.

Description.—*Female:* Head. Eyes sparsely setose. Malar space 1/6 shorter than intertentorial line, or equal to 2/5 width of eye. Tentoriocular line 1/6 shorter than intertentorial line. Maxillary palpus 4-segmented, labial palpus 3-segmented. Antenna 16–17 segmented, thickened in apical half; flagellomere 1 (=F_1) (Fig. 12) twice as long as wide, longest setae almost perpendicular, subequal to width of segment, with 0–1 longitudinal placode. F_2 (Fig. 13) slightly longer than F_1, with 3 longitudinal placodes. Middle F (Fig. 14) about 1/4 wider than F_1, 1.5 times as long as wide, setae semiperpendicular, equal to 2/3 width of segment, with 6 longitudinal placodes; preapical F (Fig. 15) as wide as middle F.

Mesosoma.—Pronotum with antescutal depression (Fig. 6). Mesonotum (Fig. 1) with distinct, crenulate-rugose notauli anteriorly, sparsely setose, finely punctate, with glabrous areas on central and lateral lobes. Propodeum (Fig. 8) with distinct central areola, several additional carinae inside areola, with relatively dense, long setae in upper lateral areola.

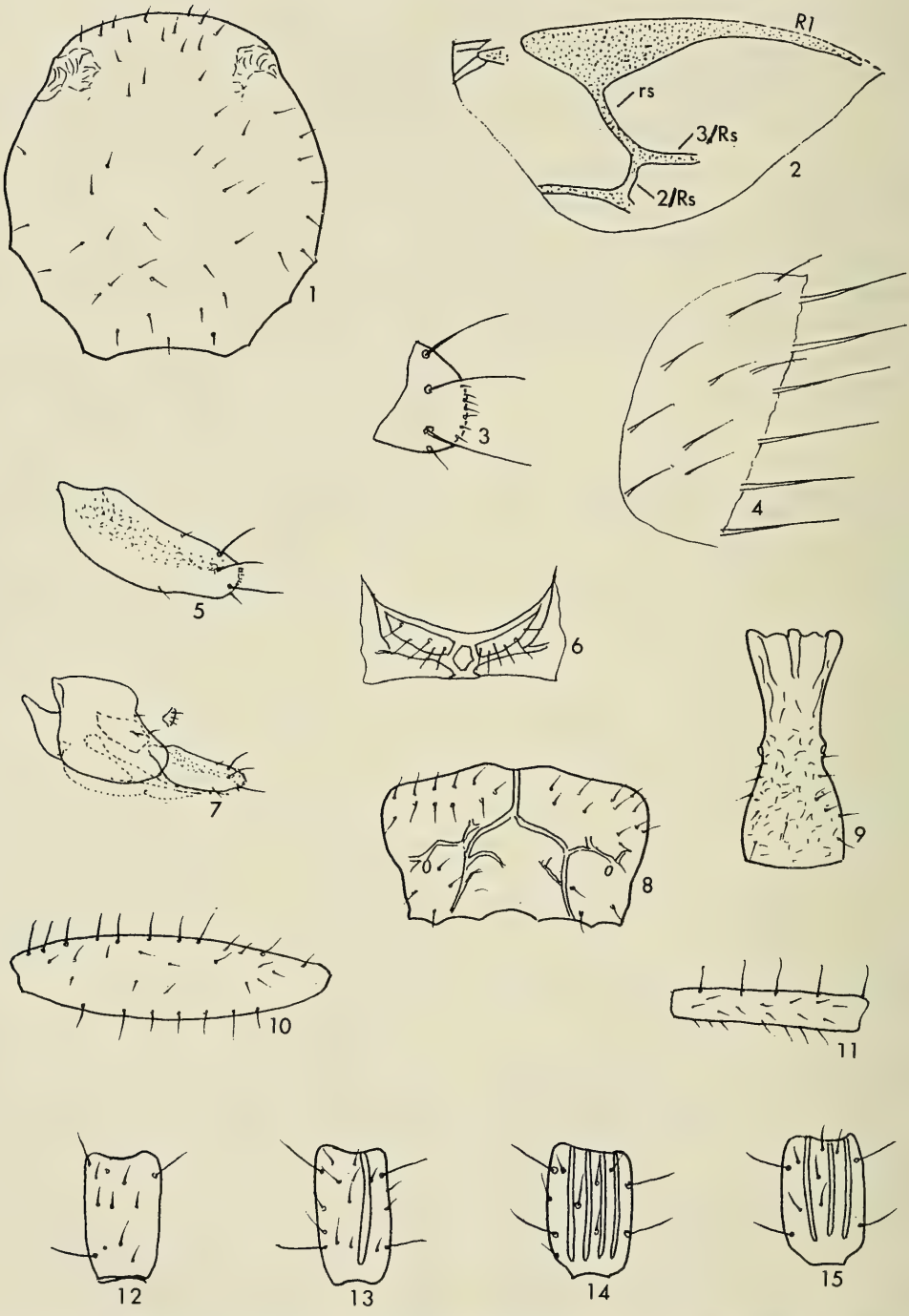
Forewing (Figs. 2, 4).—Stigma length 3 times width, distal abscissa of R1 subequal to stigma length. Vein rs, slightly greater than width of stigma, about twice as long as vein 2/Rs, and longer than vein 3/Rs; lower marginal wing setae (Fig. 4) twice as long as surface hairs.

Legs.—Hind femur (Fig. 10) with long, perpendicular setae on anterior and posterior margins, length less than half diameter of femur. Hind tibia (Fig. 11) with long, perpendicular setae on anterior margin, equal in length to diameter of tibia, semierect setae on posterior margin.

Metasoma.—Tergum 1 (Fig. 9) length 3 times width across spiracles at mid-segment; width at apex 1/4 to 1/3 greater than width across spiracles; coarsely rugose, sparsely setose; anterolateral area rugose.

Genitalia (Figs. 3, 5, 7).—Apical setae of ovipositor sheath with simple circular bases (Fig. 3).

Coloration.—Head dark brown, central part of face with patterns of yellow brown to completely brown. Clypeus yellow brown to brown. Mouthparts yellow, apex of mandible brown. Antenna brown, apical ring of pedicel yellow. Prothorax yellow. Mesonotum yellow brown, with small or large brown spots on central and lateral lobes. Mesopleuron brown with small or large yellow patterns. Scutellum, metapleuron and propodeum brown; metanotum sometimes with lighter patterns in lower portion. Tegula yellow. Wing venation brown; stigma uniformly brown. Legs yellow brown, middle and hind femur and tibia sometimes dark, apex of tarsus infuscated.



Figs. 1–15. *Pauesia ahtanumensis,* female paratypes (illustrations not to equal scale). 1, Mesonotum. 2, Forewing, in part. 3, Apex of ovipositor sheath. 4, Forewing surface and lower marginal setae, close-up. 5, Ovipositor sheath. 6, Antescutal depression of pronotum. 7, Genitalia. 8, Propodeum. 9, Metasomal tergum 1. 10, Hind femur. 11, Hind tibia, central part. 12, Flagellomere 1. 13, Flagellomere 2. 14, Middle flagellomere. 15, Preapical flagellomere.

Metasoma yellow brown, apical third dark brown. Ovipositor sheath dark brown.

Length of body about 2.6–3.0 mm.

Male: Antenna 19–21 segmented. Coloration similar but generally darker than female. Pronotum yellow brown. Mesosoma largely uniformly dark brown; propleuron often brown; mesonotum with yellow brown margins near the base of notauli.

Holotype.—Female. USA, WA, Yakima Co., Ahtanum Valley, 3-VI-1994, P. Starý & K. S. Pike. Host: *Cinara ponderosae* (Williams) on *Pinus ponderosa* Douglas, sample 94–65. Deposited in USNM, Washington D.C., Type No. 105346.

Paratypes. 65 females; 75 males, same data as holotype (Sample no. 94-95). Deposited in part in the Washington State University Collection, James Museum, Pullman, Washington; the Washington State University Collection-Prosser, Washington; the collection of P. Starý, Ceské Budejovice, Czech Republic; and the USNM, Washington D.C.

Note.—Mummified aphids are black.

Pauesia pahtonis Pike and Starý, New Species
(Figs. 16–28)

Diagnosis.—This new species belongs to a group of species characterized by an incomplete areola on the propodeum, i.e. longitudinal carinae are absent. The new species is distinguished from others by having a 20-segmented antenna (variation unknown, possibly range 19–21), delicately sculptured and uniformly black mesonotum with notauli indicated over most of the surface.

Etymology.—The name of the species is derived from the aboriginal Yakama name of a volcano near the type locality, Pahto (Mt. Adams).

Description.—*Female:* Eye sparsely setose. Tentoriocular line and malar space ⅔ intertentorial line, also, subequal to ⅓ width of eye. Maxillary palpus 4-segmented, labial palpus 3-segmented. Antenna 20-segmented (variation unknown), not thickened in apical half. Flagellomere 1 (=F_1) (Fig. 25) less than twice as long as wide, longest semi-perpendicular setae somewhat longer than half width of segment, with 4 longitudinal placodes. F_2 (Fig. 26) equal to F_1. Middle F (Fig. 27) equal to F_1, with 8 longitudinal placodes. Preapical F (Fig. 28) as wide as F_1.

Mesosoma.—Mesonotum (Fig. 16) with distinct, crenulate-rugose notauli in ascendent portion, then weakly traced as indicated over granularly punctate sculptured surface, sparsely setose with distinct glabrous areas on central and lateral lobes. Propodeum (Fig. 22) with incomplete central areola, longitudinal carinae absent, upper lateral areolae with relatively dense and unusually long setae.

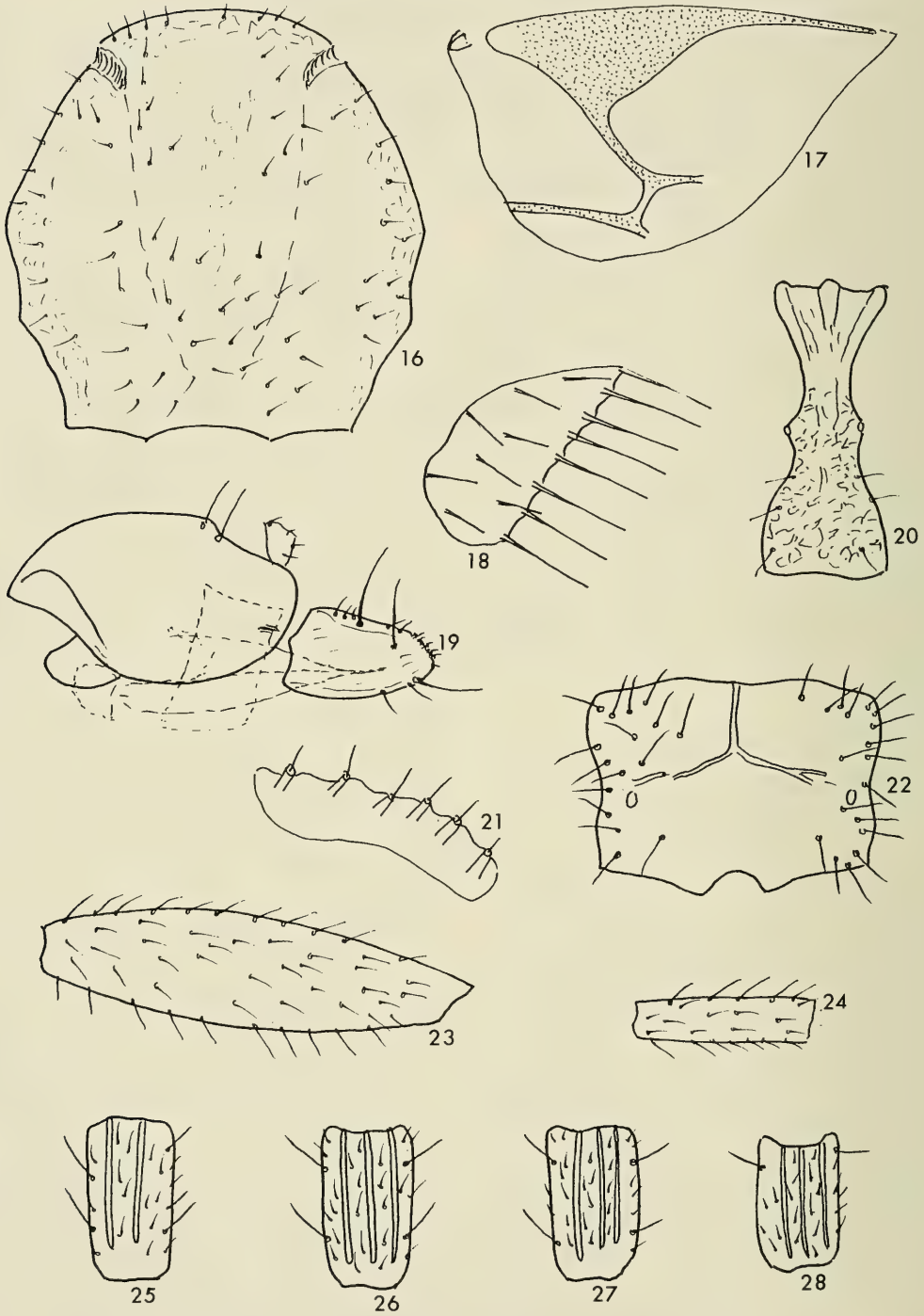
Forewing (Figs. 17, 18).—Stigma length about 2.5 times width; distal abscissa of R1 slightly longer than half of stigma; vein rs subequal to width of stigma; twice as long as 2/Rs, and longer than 3/Rs; lower marginal setae twice as long as those on wing surface. (Fig. 18).

Legs.—Hind femur (Fig. 23) with semi-erect setae on margins, subequal to ⅓ diameter of femur. Hind tibia (Fig. 24) with semi-erect setae subequal to diameter of tibia.

Metasoma.—Tergum 1 (Fig. 20) length about 3.5 times width across spiracles at mid-segment; width at apex about 1.5 times width across spiracles; coarsely rugose, sparsely setose; anterolateral area rugose.

Genitalia (Figs. 19, 21).—Apical setae of ovipositor sheath with tubiform bases (Fig. 21).

Coloration.—Head black. Mouthparts testaceous to light brown, apex of mandible brown. Antenna dark brown. Mesonotum entirely black, prothorax dark brown. Tegula brown. Wing venation brown; stigma brown with white basal corner. Fore and middle legs largely testaceous, with trochanters, trochantelli and anterior part of femora brown; hind legs brown. Metasoma brown; tergum 1 dark brown. Ovipositor sheath brown.



Figs. 16–28. *Pauesia pahtonis,* female paratypes (illustrations not to equal scale). 16, Mesonotum. 17, Forewing, in part. 18, Forewing surface and lower marginal setae, close-up. 19, Genitalia. 20, Metasomal tergum 1. 21, Apex of ovipositor sheath. 22, Propodeum. 23, Hind femur. 24, Hind tibia, central part. 25, Flagellomere 1. 26, Flagellomere 2. 27, Middle flagellomere. 28, Preapical flagellomere.

Length of body about 3.0–3.2 mm.

Male: Antenna 22-segmented. Coloration similar to female, but generally darker; mouthparts brown, stigma uniformly brown.

Holotype.—Female. USA, WA, Skamania Co., Goose Lake, 8-VI-1994, P. Starý & K. S. Pike. Host: *Cinara ponderosae* (Williams) on *Pinus ponderosa* Douglas (young trees along roadside, coniferous forest), sample no. 94-131. Deposited in USNM, Washington D.C., Type No. 105347.

Paratypes.—3 females; 4 males (sample nos. 94-131), same data as holotype. Deposited in part in the Washington State University Collection, James Museum, Pullman, Washington; the Washington State University Collection-Prosser, Washington; and the collection of P. Starý, Ceské Budejovice, Czech Republic.

Pauesia ponderosaecola Pike & Starý, New Species
(Figs. 29–41)

Diagnosis.—This new species belongs to a group of species manifesting an incomplete areola on the propodeum where longitudinal carinae are lacking. It is related to *P. ponderosae* (Muesebeck), but differs in having 22–23 segmented antenna (female), presence of stubs of longitudinal carinae on the propodeum, and coloration.

Etymology.—The name of the new species is derived from its association with the ponderosa pine forest.

Description.—*Female:* Head. Eye sparsely setose. Tentoriocular line equal to ⅔ intertentorial line, ⅓ width of eye. Maxillary palpus 4-segmented, labial palpus 3-segmented. Antenna 22–23 segmented, not thickened in apical half. Flagellomere 1 (=F_1) (Fig. 38) length less than 2 times width, setae semiperpendicular and slightly longer than half diameter of segment, with 5-6 longitudinal placodes. F_2 (Fig. 39) equal to F_1, with 6–7 longitudinal placodes. Middle F (Fig. 40) and preapical F (Fig. 41) similar to F_1, with 7–9 longitudinal placodes.

Mesosoma.—Mesonotum (Fig. 29) with distinct, crenulate-rugose notauli anteriorly, sparsely setose, with glabrous areas on the central and lateral lobes; granularly punctate sculptured, with notauli indicated over most of the surface. Propodeum (Fig. 32) with incomplete areola, longitudinal carinae missing, upper lateral areolae with relatively dense, long setae.

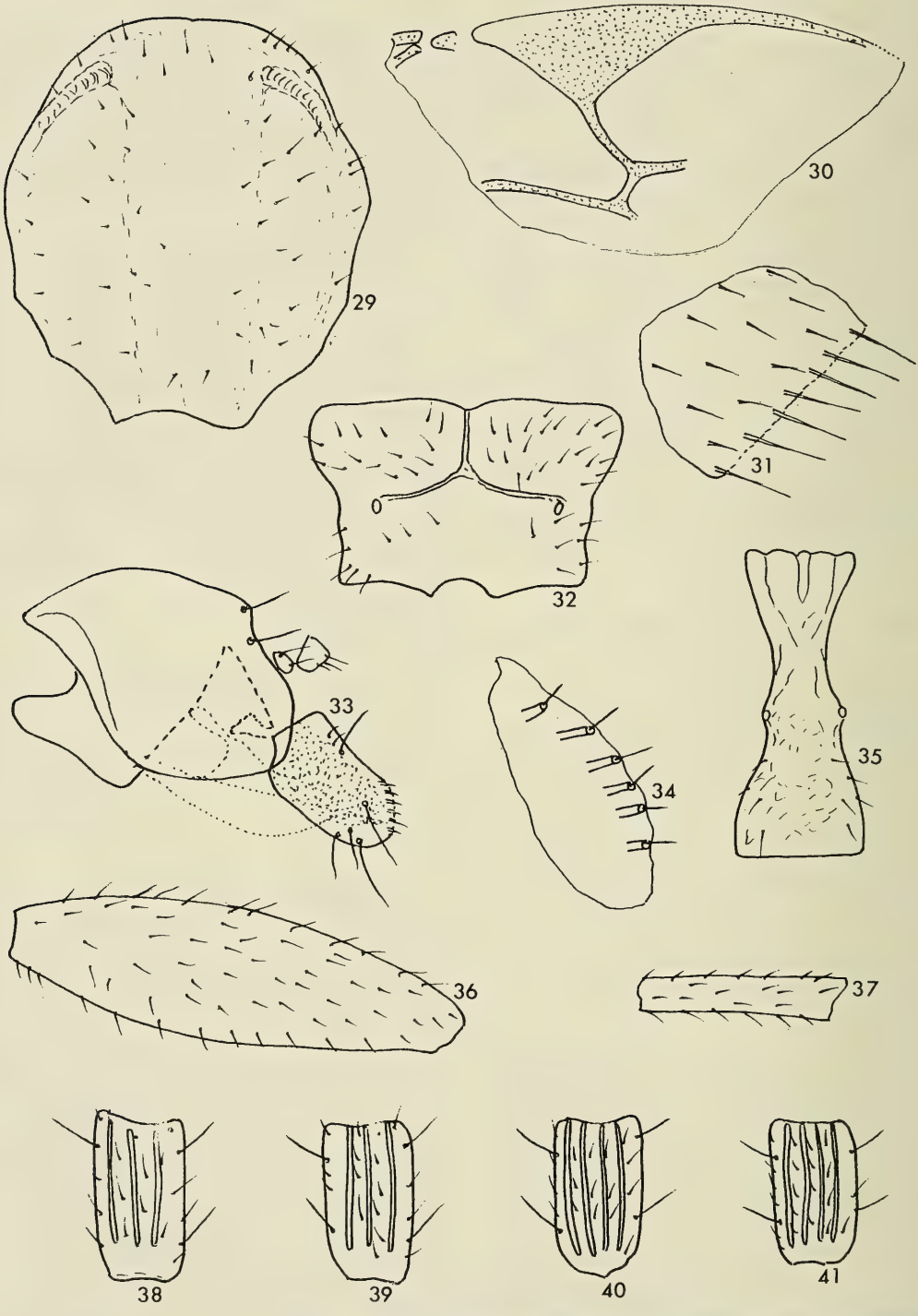
Forewing (Figs. 30, 31).—Stigma length 2.5 times width. Distal abscissa of R1 about ⅔ length of stigma. Vein rs about equal to width of stigma, distinctly longer than 2/Rs and 3/Rs. Lower marginal setae twice as long as those on wing surface (Fig. 31).

Legs.—Hind femur (Fig. 36) with semierect setae on anterior and posterior margins. Length of anterior marginal setae subequal to ⅓ diameter of femur, ⅓ longer than posterior marginal setae. Hind tibia (Fig. 37) with semierect setae on anterior and posterior margins, length greater than half diameter of tibia.

Metasoma.—Tergum 1 (Fig. 35) length 4 times width across spiracles at mid-segment; width at apex about 1.5 times width across spiracles; anterolateral area rugose.

Genitalia (Figs. 33, 34).—Apical setae of ovipositor sheath with tubiform bases (Fig. 34).

Coloration.—Head yellow orange, vertex and most of occiput brown. Mouthparts yellow, apex of mandible brown. Antenna dark brown; scape brown, with lighter markings, rarely yellow orange; pedicel with yellow orange apical ring. Mesosoma distinctly bicolorous; prothorax and mesonotum yellow orange, without dark spots; remaining mesosoma dark brown; mesopleuron with narrow, slightly yellow markings along suture with prothorax. Tegula yellow. Wing venation brown, stigma with distinct whitish basal corner connecting prestigma. Fore and middle legs and coxae yellow orange, sometimes middle coxa brown, with tibia and apex of tarsus infuscate. Hind legs brown, hind coxa dark brown. Metasomal tergum 1 brown, tergum 2 yellow with brown central spot, remaining terga yellow



Figs. 29–41. *Pauesia ponderosaecola,* female paratypes (illustrations not to equal scale). 29, Mesonotum. 30, Forewing, in part. 31, Forewing surface and lower marginal setae, close-up. 32, Propodeum. 33, Genitalia. 34, Apex of ovipositor sheath. 35, Metasomal tergum 1. 36, Hind femur. 37, Hind tibia, central part. 38, Flagellomere 1. 39, Flagellomere 2. 40, Middle flagellomere. 41, Preapical flagellomere.

with broad brown lower margins. Ovipositor sheath brown.

Length of body about 3.3–3.8 mm.

Male: Coloration generally much darker than female. Head dark brown, face, clypeus and malar space yellow brown, mouthparts somewhat lighter, apex of mandible brown. Mesosoma dark brown; prothorax brown with yellow brown markings, rarely yellow brown. Mesonotum with brown anterior margin. Tegulae, wing venation and legs same as female. Metasomal tergum 1 brown, middle part of metasoma brown, apical part dark brown.

Holotype.—Female. USA, WA, Yakima Co., Ahtanum Valley, 3-VI-1994, P. Starý & K. S. Pike. Host: *Cinara ponderosae* (Williams) on *Pinus ponderosa* Douglas (young shoots), sample no. 94-65. Deposited in USNM, Washington D.C., Type No. 105348.

Paratypes.—12 females; 11 males (sample nos. 94-95, 94-96), same data as holotype. Deposited in part in the Washington State University Collection, James Museum, Pullman, Washington; the Washington State University Collection-Prosser, Washington; and the collection of P. Starý, Ceské Budejovice, Czech Republic.

Note.—Mummified aphids are black.

Acknowledgments

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LIFE HISTORY AND DESCRIPTION OF IMMATURE STAGES OF *DIOXYNA PICCIOLA* (BIGOT) (DIPTERA: TEPHRITIDAE) ON *COREOPSIS* SPP. (ASTERACEAE) IN SOUTHERN CALIFORNIA

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Abstract.—*Dioxyna picciola* (Bigot) is bivoltine or trivoltine and oligophagous primarily on *Coreopsis* and *Bidens* spp. in southern California. It is a late-stage, aggregated attacker in flower heads at or past anthesis. Mating and oviposition by overwintered F_2 and F_3 adults occurs in spring on wild and cultivated *Coreopsis* spp. Eggs are inserted into soft achenes in which the first two instars and most early-third instars feed solitarily; the late-third instars also feed on sap, and at higher larval densities, score the receptacles and feed on sap accumulated in shallow depressions. Pupariation occurs in heads, with puparia resting in the feeding depressions, or in flower heads containing only a single larva, within hollowed out achenes and situated well above the receptacle. Adults are synovigenic, sexually immature at eclosion, but exceptionally long-lived as the overwintering stage. This tephritid is known in North America as *D. picciola,* but it recently was synonymized with the cosmopolitan *D. sororcula,* but unlike the latter species, Nearctic flies have not been reported from *Calendula officinalis* L. The egg is described and illustrated and differs from the eggs of two other species in the closely related genus *Campiglossa* (=*Paroxyna*) by the elongate, apically expanded pedicel, which bears aeropyles apically. First through third instars and the puparium also are described and illustrated. Third instars of *D. picciola* are similar in morphology to those of *Campiglossa genalis* (Thomson), but are more elongate and cylindrical, have a gnathocephalon that is broader apically, with serrated rugose pads dorsomediad of the anterior sensory lobes. The anterior sensory lobes are larger and more prominent and the serrated rugose pads laterad of the mouth lumen are larger and more numerous than in two *Campiglossa* spp. that have been described in similar detail. Behaviors of adults of *D. picciola* and *C. genalis* in southern California were similar, but differed in several respects from *D. picciola* on *C. officinalis* in India. Wing lofting by *D. picciola* and such unique aspects of its mating behavior in southern California as its copulatory induction behavior and mate guarding are described.

Key Words: Insecta, *Dioxyna picciola, D. sororcula,* nonfrugivorous Tephritidae, mating behavior, immature stages, Asteraceae, flower-head feeding

The genus *Dioxyna* is widespread in the New World, but is represented by only two species in North America, *D. picciola* (Bigot 1857) and *D. thomae* (Curran) (Foote et al. 1993). Of these two species, only the former occurs in California.

Dioxyna is closely related to *Campiglossa* (Merz and Freidberg 1994); Foote (1980) suggested that a thorough and detailed study of the New World species was required to further distinguish the species within these two genera. This paper provides the first de-

tailed description of the biology, immature stages, adult behavior, and host-plant relationships of *D. picciola* to compare with similar aspects of the life history and taxonomy of the immature stages of *Campiglossa genalis* (Thomson) (Goeden et al. 1994b). Behavioral comparisons of adults are made with reference to Headrick and Goeden (1995) between our findings in California and descriptions from India by Grewal and Kapoor for *D. sororcula* (1984).

Materials and Methods

A planting of ornamental *Coreopsis* sp. in the garden of DHH at 340 m in Riverside, CA, provided the main site for observing the field behavior of *D. picciola* during 1991 and 1992. This and additional plantings of ornamental *Coreopsis* in the gardens of RDG and JAT at 260 to 370 m elevations in Riverside, California, were used to supplement 1-liter samples of mature flower heads collected by RDG and coworkers from wild hosts in southern California since 1980 (Goeden and Blanc 1986; Goeden 1985, 1987, 1989, 1992, 1994). Samples of mature and immature flower heads were returned to the laboratory for dissection, photography, description, and measurement, or for bulk cagings in glass-topped sleeve cages in the insectary of the University of California, Riverside at 27 ± 1°C and a 14-h photophase. A total of 1144 flower heads in six random subsamples of 200 heads each from 1-liter samples from wild hosts, plus 82 heads from cultivars, were dissected to study the immature stages of *D. picciola*. Four eggs, 20 larvae, and 4 puparia obtained from dissections were preserved in 70% EtOH for scanning electron microscopy (SEM). All other puparia were placed in separate glass rearing vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult emergence. Specimens for SEM later were hydrated to distilled water in a decreasing series of acidulated EtOH, critical-point dried, mounted on stubs, sputter coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 scanning electron microscope in the Department of Nematology, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screen-topped cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cagings were used for longevity studies and oviposition tests. Virgin male and female flies obtained from emergence vials, as well as field-collected adults, were paired in clear-plastic petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey for direct observations, video-recording, and still-photography of their general behavior, courtship, and copulation (Headrick and Goeden 1995). Six pairs of flies were held together for at least 14 d and observations of their behaviors were made as opportunity allowed throughout each day. Field studies were conducted in the garden of DHH as noted above, in which adult reproductive behavior was described and quantified according to the methods developed and described by Headrick and Goeden (1995).

Plant names used in this paper follow Munz and Keck (1959) and Munz (1968, 1974); names for flower head parts follow Hickman (1993). Tephritid names and anatomical terms follow Foote et al. (1993), except for *picciola* (Norrbom, pers. comm. 1994); nomenclature used to describe the immature stages follows Goeden and Headrick (1990, 1991a, b, 1992), Headrick and Goeden (1990, 1991, 1993), and the telegraphic format of Goeden et al. (1993, 1994a, b). Means ± SE are used throughout this paper. Voucher specimens of reared adults of *D. picciola* and its parasitoids reside in the research collections of RDG; preserved specimens of larvae and puparia are stored in separate collections of immature Tephritidae maintained by JAT and DHH.

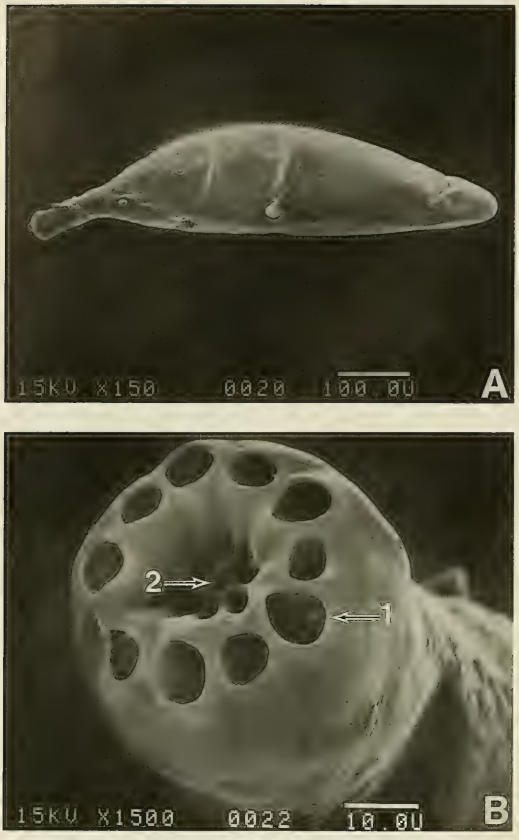

Fig. 1. Egg of *Dioxyna picciola.* (A) Habitus; (B) apical end of pedicel, 1—aeropyles, 2—micropyle.

Results and Discussion

Taxonomy

This species was generally known as *Dioxyna picciola* (Bigot) throughout North America (Novak 1974) and in California (Foote and Blanc 1963) until Hardy (1988) synonymized *D. picciola* with the cosmopolitan species, *D. sororcula.* Foote et al. (1993) adopted this change, as did we (Headrick and Goeden 1995) in deference to them, but A. L. Norrbom (pers. comm. 1994) has since indicated that the North American species is not *sororcula.* We tentatively use the name *D. picciola* in this paper. Munro (1957) discussed the genus *Dioxyna,* its relationship to *Campiglossa* (as *Paroxyna,* synonymized by Merz and Friedberg 1994) in the Afrotropical Region, and the separate taxonomic status of *D. picciola* and *D. sororcula,* but without resolving this question. Novak (1974) discussed and provided keys to the two U.S. species.

Benjamin (1934) sketched the egg and provided generalized descriptions and sketches of the third instar larva and puparium (as *Paroxyna picciola*). Phillips (1946) described the third instar and illustrated its cephalopharyngeal skeleton, anterior spiracles, and caudal end, including the posterior spiracles and interspiracular processes. Otherwise, the immature stages of *D. picciola* from North America are described and illustrated herein in detail for the first time.

Egg.—Body smooth, shiny white, elongate-ellipsoidal (Fig. 1A); six egg bodies averaged 0.78 ± 0.02 (range, 0.72–0.84) mm in length, 0.17 ± 0.01 (range, 0.16–0.18) mm in width; anterior end of the egg drawn out into a stout 0.14 ± 0.01 (range, 0.12–0.16) mm-long (n = 4), 0.08 mm-wide (n = 2) pedicel, apical end of pedicel slightly enlarged (Fig. 1A), aeropyles open apically on pedicel (Fig. 1B-1), a central, sunken, group of apertures may serve as the micropyle (Fig. 1B-2); posterior end of egg rounded, tapering gradually.

The egg sizes given herein are similar to those reported for *D. sororcula* in India by Jakhmola (1983); however, an elongate pedicel was not specifically mentioned. The egg morphology of two closely related species, *Campiglossa albiceps* (Loew) (Novak and Foote 1968) and *C. genalis* (Thomson) (Goeden et al. 1994b), differs considerably from *D. picciola,* as both species have a

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Fig. 2. Third instar of *D. picciola.* (A) Habitus, anterior to left; (B) gnathocephalon, anterior view, 1—serrated rugose pads, 2—dorsal sensory organ, 3—anterior sensory lobe, 4—mouth hooks, 5—median oral lobe; (C) anterior

sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ, 6—stomal sense organ; (D) anterior thoracic spiracle; (E) lateral spiracular complex, metathorax, 1—spiracle, 2—stelex sensillum, 3—verruciform sensillum; (F) lateral spiracular complex, first abdominal segment, 1—spiracle, 2—verruciform sensillum; (G) caudal segment, posterior spiracular plates, 1—rima, 2—interspiracular process; (H) compound sensillum, 1—stelex sensillum, 2—medusoid sensillum.

non-elongated, mammiloid pedicel similar to most of the Tephritini that we have described thus far, *cf.,* Goeden et al. (1993, 1994b), Headrick and Goeden (1991), Goeden and Headrick (1991a). The aeropyle openings in these species circumscribe only the lateral aspect of the pedicel, not the apical end as in *D. picciola.*

Third instar.—Elongate, cylindrical, anterior and posterior ends rounded, superficially smooth, minute acanthae circumscribe intersegmental areas (Fig. 2A); gnathocephalon conical with serrated rugose pads laterad and dorsomediad of anterior sensory lobes (Fig. 2B-1); dorsal sensory organ comprised of single, dome-shaped papilla dorsal to anterior sensory lobes (Figs. 2B-2, 2C-1); anterior sensory lobe (2B-3, 2C), bears terminal sensory organ (Fig. 2C-2), pit sensory organ (Fig. 2C-3), lateral sensory organ (Fig. 2C-4), and supralateral sensory organ (Fig. 2C-5); stomal sense organs ventrolaterad of anterior sensory lobes (Fig. 2C-6); mouth hooks bidentate, teeth stout, conical (Fig. 2B-4); median oral lobe laterally flattened, attached to labial lobe (Fig. 2B-5); anterior spiracles protruding, bearing five rounded papillae apically (Fig. 2D); metathoracic lateral spiracular complex consists of spiracle (Fig. 2E-1), stelex sensillum (Fig. 2E-2) and single verruciform sensillum (Fig. 2E-3); abdominal lateral spiracular complex consists of spiracle (Fig. 2F-1) and two verruciform sensilla (Fig. 2F-2); caudal segment bears posterior spiracular plates; posterior spiracular plates raised, bearing three oval rimae ca. 0.025 mm long (Fig. 2G-1), and four lanceolate interspiracular processes with two to four branches each, longest measuring 0.013 mm (Fig. 2G-2); stelex sensilla circumscribe margin of caudal segment; compound sensilla ventrad of posterior spiracular plates consist of stelex sensilla (Fig. 2H-1), and raised, medusoid sensilla with minute papillae (Fig. 2H-2).

The third instar of *Dioxyna picciola* closely resembles *C. albiceps* (Novak and Foote 1968) and *C. genalis* (Goeden et al. 1994b) morphologically, but is more elongate and cylindrical in body shape and the gnathocephalon is broader apically, with serrated rugose pads dorsomediad of the anterior sensory lobes. The anterior sensory lobes are larger and more prominent in *D. picciola* than in the two *Campiglossa* spp., and the serrated rugose pads laterad of the mouth lumen are larger and more numerous. The anterior thoracic spiracles are very similar in *D. picciola* and *C. genalis,* each bearing 4–5 rounded papillae; whereas, the anterior spiracles of *C. albiceps* bear 12–13 papillae (Novak and Foote 1968). The metathoracic lateral spiracular complex of *D. picciola* has only a single verruciform sensillum; whereas, *C. genalis* has two verruciform sensilla (Goeden et al. 1994b). The abdominal lateral spiracular complexes of *D. picciola* lack campaniform sensilla and the third verruciform sensilla reported for *C. genalis* (Goeden et al. 1994b). To date, *D. picciola* and *C. genalis* are the only species known with a stelex sensillum associated with the lateral spiracular complex, and the posterior spiracular plates and the type of sensory structures on them are similar. The compound sensilla of these two species also are similar to those of *Tephritis arizonaensis* Quisenberry (Goeden et al. 1993), *Trupanea bisetosa* (Coquillett), and *T. nigricornis* (Coquillett) (Knio et al. 1995).

Second instar.—Elongate cylindrical, anterior and posterior ends rounded (Fig. 3A); minute acanthae circumscribe intersegmental areas (Fig. 3A); gnathocephalon conical (Fig. 3B); rugose pads mediad and laterad of anterior sensory lobes, lateral pads ser-

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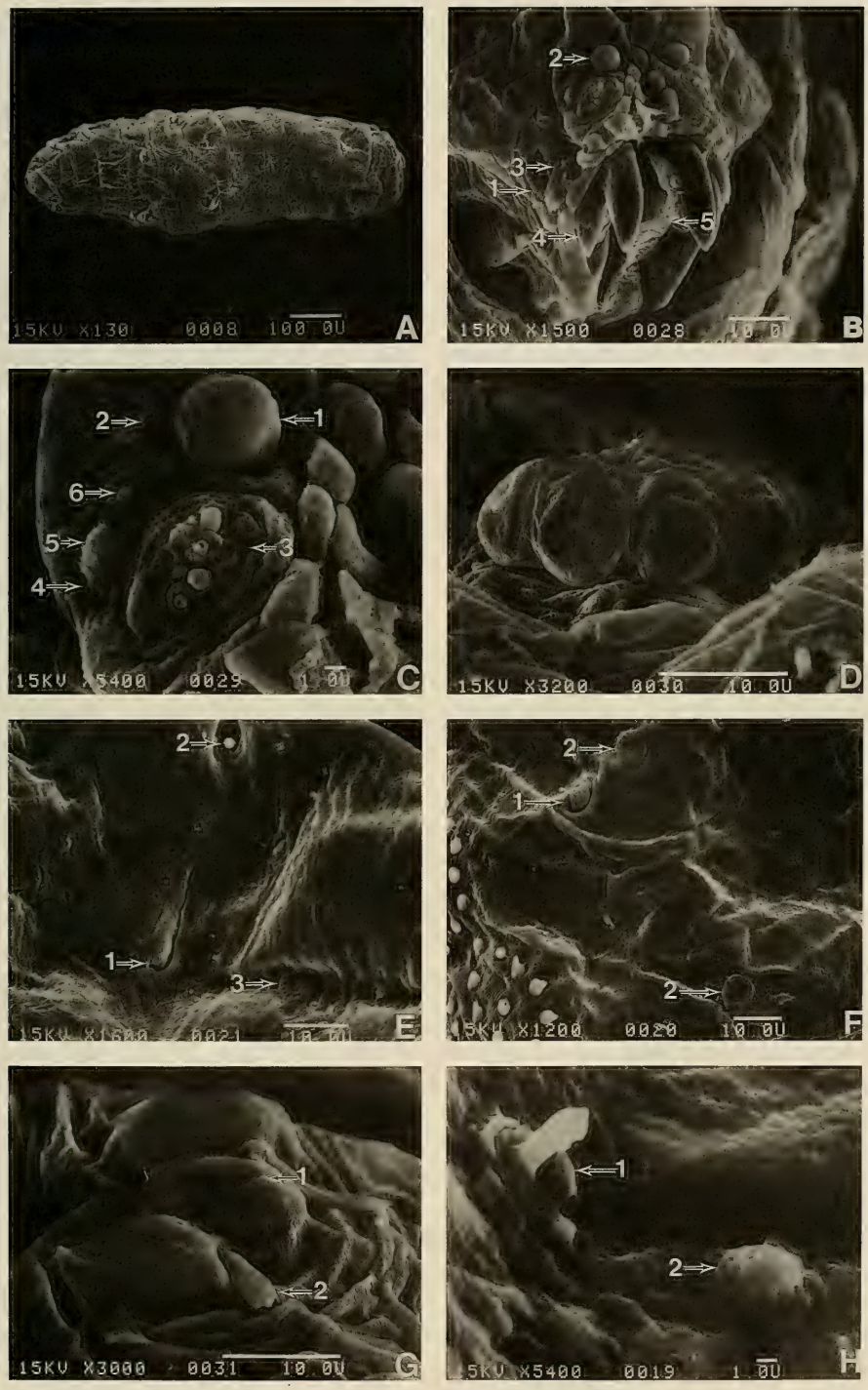
Fig. 3. Second instar of *D. picciola.* (A) Habitus, anterior to left; (B) gnathocephalon, anterior view, 1—serrated rugose pads, 2—dorsal sensory organ, 3—stomal sense organ, 4—mouth hooks, 5—median oral lobe; (C)



anterior sensory lobe, 1—dorsal sensory organ, 2—sensillum, 3—terminal sensory organ, 4—pit sensory organ, 5—lateral sensory organ, 6—supralateral sensory organ; (D) anterior thoracic spiracle; (E) lateral spiracular complex, metathorax, 1—spiracle, 2—stelex sensillum, 3—verruciform sensillum; (F) lateral spiracular complex, first abdominal segment, 1—spiracle, 2—verruciform sensilla; (G) caudal segment, posterior spiracular plates, 1—rima, 2—interspiracular process; (H) compound sensillum, 1—stelex sensillum, 2—dome-shaped sensillum.

rated (Fig. 3B-1); dorsal sensory organ comprised of single, dome-shaped papilla dorsal to anterior sensory lobe (Fig. 3B-2, 3C-1); small sensillum laterad of dorsal sensory organ (Fig. 3C-2); anterior sensory lobes bear terminal sensory organ (Fig. 3C-3), pit sensory organ (Fig. 3C-4), lateral sensory organ (Fig. 3C-5) and supralateral sensory organ (Fig. 3C-6); stomal sense organs laterad of mouth lumen, serrated on ventral margins (Fig. 3B-3); mouth hooks bidentate (Fig. 3B-4); median oral lobe laterally flattened, ventrally attached to labial lobe (Fig. 3B-5); anterior spiracles dorsolateral on posterior margin of prothorax, each bear five rounded papillae (Fig. 3D); metathoracic lateral spiracular complex consists of spiracle (Fig. 3E-1), stelex sensillum (Fig. 3E-2), and a verruciform sensillum (Fig. 3E-3); abdominal lateral spiracular complex consists of spiracle (Fig. 3F-1) and two verruciform sensilla (Fig. 3F-2); caudal segment bears the posterior spiracular plates; posterior spiracular plates bear three oval rimae ca. 0.013 mm long (Fig. 3G-1), and four, single remiform interspiracular processes, longest measuring 0.011 mm (Fig. 3G-2); stelex sensilla surround margin of caudal segment; compound sensilla ventrad of posterior spiracular plates consist of stelex sensillum (Fig. 3H-1), and dome-shaped sensillum (Fig. 3H-2).

The second instar differs from the third instar in being more cylindrical. The gnathocephalon of the second instar is conical, not as broad as that in the third instar. The serrated rugose pads located dorsomediad of the anterior sensory lobes on the third instar are lacking in the second instar. There also are fewer serrated rugose pads laterad of the mouth lumen in the second instar. A small sensillum located laterad of the dorsal sensory organ was found in the second instar, but not observed in the third instar. A similar sensillum was described from the first instar of *T. nigricornis* (Knio et al. 1995). Sensory structures are usually maintained in the third instar if they are present in the earlier instars (Headrick and Goeden 1990). The lateral spiracular complexes on the thoracic and abdominal segments of the second instar are similar in placement and structure to those of the third instar. The posterior spiracular plates of the second instar are not as anatomically distinct as those of the third instar, the rimae are smaller and the interspiracular processes have not differentiated into multiple blades.

First instar.—Elongate cylindrical, anterior and posterior ends rounded (Fig. 4A); gnathocephalon smooth, lacking rugose pads (Fig. 4B); dorsal sensory organ is a single, dome-shaped papilla (Fig. 4B-1, 4C-1); anterior sensory lobes (Fig. 4B-2, 4C), bear the terminal sensory organ (Fig. 4C-2), pit sensory organ (Fig. 4C-3), lateral sensory organ (Fig. 4C-4), and supralateral sensory organ; stomal sense organs indistinct; mouth hooks bidentate, teeth conical (Fig. 4B-3); median oral lobe laterally flattened and ventrally attached to labial lobe (Fig. 4B-4); anterior spiracles not present; lateral spiracular complex not observed; posterior spiracular plates bear two oval rimae ca. 0.004 mm long (Fig. 4D-1), and four interspiracular processes, longest measuring 0.005 mm (Fig. 4D-2); compound sensilla not seen.

Puparium.—Light brown, elongate, cylindrical, smooth, rounded at both ends, acanthae circumscribe intersegmental areas (Fig. 5A); length 2.5 ± 0.03 (range, 2.37–2.88) mm, width 1.04 ± 0.01 (range, 0.86–1.18) mm (n = 28); anterior end bears the invagination scar (Fig. 5B-1) and raised anterior spiracles, each with 4–5 rounded papillae (Fig. 5B-2); posterior spiracular plates bear slightly raised oval rimae, ca. 0.034 mm long (Fig. 5C-1), and four interspiracular processes with 1–3 branches, longest branch measuring 0.014 mm (Fig. 5C-2).

Distribution and Hosts

The North American distribution of *D. picciola* was mapped north of Mexico by Foote et al. (1993) to include most of the

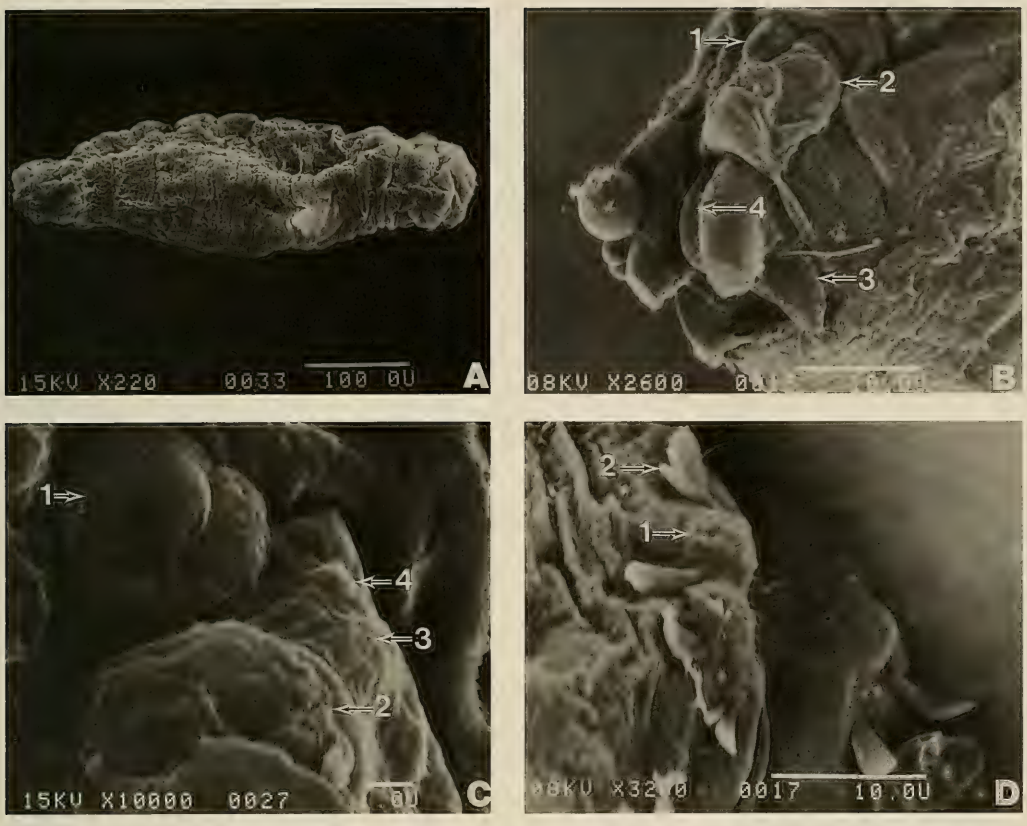


Fig. 4. First instar of *D. picciola.* (A) Habitus, anterior to left; (B) gnathocephalon, anterolateral view, 1—dorsal sensory organ, 2—anterior sensory lobe, 3—mouth hooks, 4—median oral lobe; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ; (D) caudal segment, posterior spiracular plates, 1—rima, 2—interspiracular process.

United States except for the New England States and the Province of Ontario, Canada, and eastward. Novak (1974) called its North American distribution "extensive", and like Foote et al. (1993), noted the absence of collection records from "... the upper New England States, central plains, and portions of the northern Rocky Mountain area. Distribution northward is limited to the southern borders of Alberta, Saskatchewan, and Manitoba." Records from central and southern California for *D. picciola* are common (Foote and Blanc 1963, Foote et al. 1993).

Wasbauer (1972) listed 10 species of *Bidens* and five species of *Coreopsis* as hosts of *D. picciola.* Goeden and Blanc (1986) added rearing records for an additional four species of *Coreopsis,* so that there is little doubt that both genera are hosts of this tephritid, belonging as they do to the same subtribe Coreopsidinae of the tribe Heliantheae (Munz and Keck 1959). The record in Wasbauer (1972) for *Cosmos* sp., belonging to the same subtribe, accordingly also seems plausible, as do records for *Acanthospermum* and *Tagetes,* both in the tribe Heliantheae. However, additional disparate records for *D. picciola* in Wasbauer (1972) for *Aster* in the tribe Astereae and for *Helenium* in the tribe Helenieae accordingly are suspect. Since surveys were begun by RDG in southern California in 1980, *D. picciola* has only been reared from *Coreopsis* and *Bidens* spp. even though *Aster* and *Helenium* have been extensively sam-

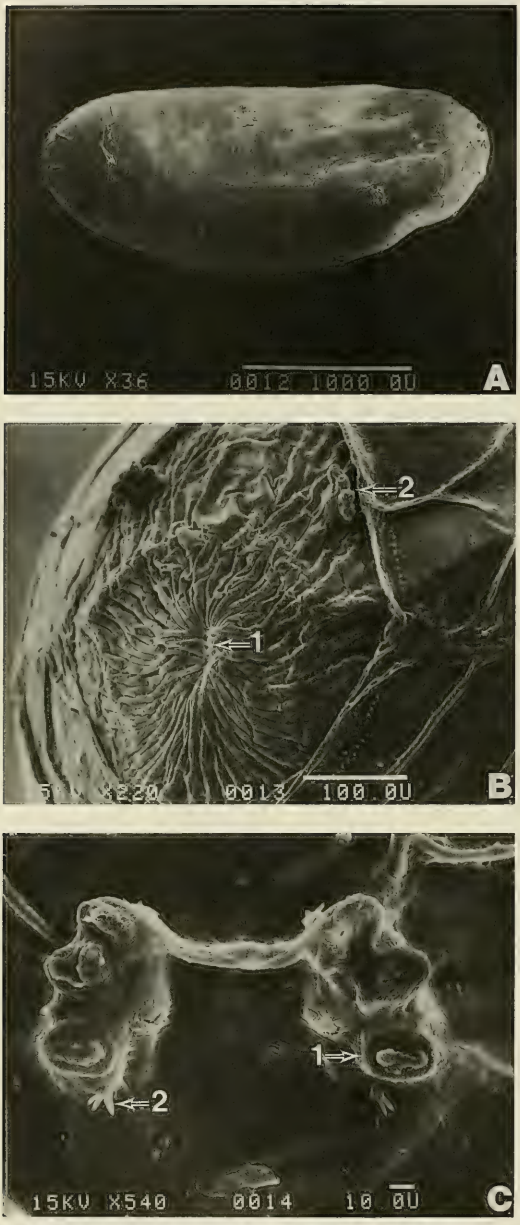


Fig. 5. Puparium of *D. picciola.* (A) Habitus, anterior to left; (B) anterior end, 1—invagination scar, 2—anterior thoracic spiracle; (C) caudal segment, posterior spiracular plates, 1—rima, 2—interspiracular process.

pled as well (Goeden and Blanc 1986; Goeden, unpub. data). *D. sororcula* studied in India by Grewal and Kapoor (1984) occurred on *Calendula officinalis* L., a host belonging to still another tribe of Asteraceae, the Calenduleae (Munz and Keck 1959). Goeden (unpublished data) has not reared *D. picciola* from two, separate collections of naturalized *C. officinalis,* nor has this tephritid been reared or otherwise reported from this cultivar in California (Foote and Blanc 1963) or elsewhere in North America (Wasbauer 1972, Foote et al 1993). This, along with Munro's initial assessment (1957) and the behavioral data reported below, indicates that contrary to Hardy (1988), *D. picciola* and *D. sororcula* probably are distinct species; although, confounding this interpretation is the report by Grewal and Kapoor (1984) of the latter species attacking achenes of the introduced weed, *Bidens pilosa* L., in India.

Biology

Egg: Females lay eggs singly, alone or successively two-three times in a flower head. Eggs are inserted directly into soft achenes of ray florets in open flower heads, or laterally through the bracts from the outside of preblossom flower heads into the lobes of the ray florets (Fig. 6A, see Oviposition, below). The pedicels remain exposed, projecting from the achene (Fig. 6A), and oviposition scars on the phyllaries are surrounded by necrotic plant tissue (Fig. 6B).

Larva: The first instar emerges from a longitudinal slit in the basal posterior end of the egg and tunnels directly into a soft achene or lobe of a ray floret. The first instar tunnels horizontally through two-three young achenes while moving centripetally toward the center of the flower head. Multiple first instars infesting a single flower head apparently avoid contact, move independently within the flower head, and feed singly in different achenes as evidenced by their feeding tunnels (Fig 6C).

Second instars continue to feed singly inside the soft achenes (Fig 6D); they tunnel through five-six adjacent achenes moving horizontally above and parallel to the receptacle toward and into the central achenes. The damage incurred by this instar

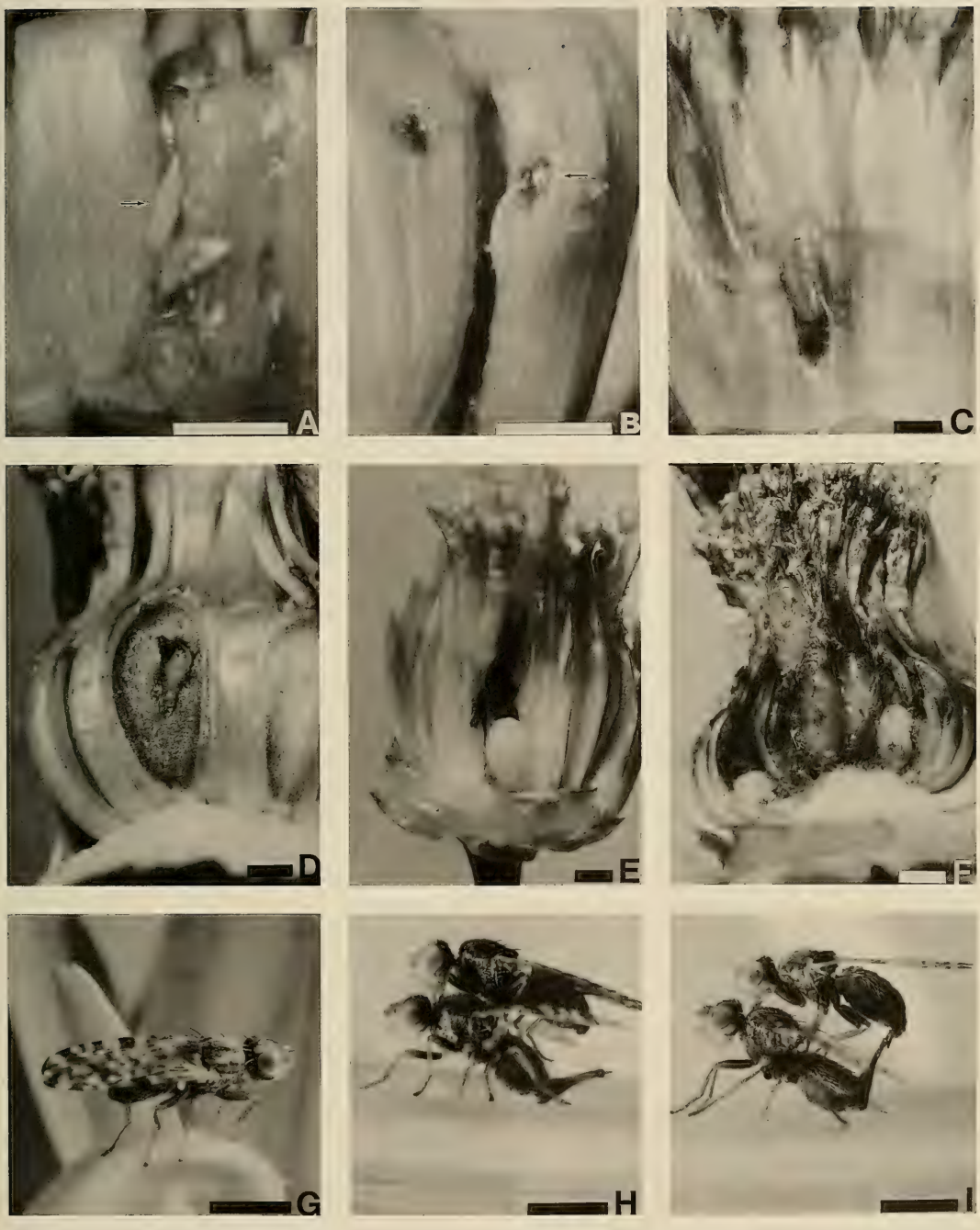


Fig. 6. Life stages of *D. picciola.* (A) Egg inserted into soft achenes of ornamental *Coreopsis* (arrow); (B) oviposition scars in phyllaries (arrow); (C) first instar mining soft achene in head of *C. bigelovii*; (D) second instar in soft achene of *Coreopsis* sp.; (E) full-size third instar feeding in center of flower head and scoring receptacle of *C. bigelovii*; (F) two central puparia and peripheral third instars in multiply-infested head of ornamental *Coreopsis* sp.; (G) newly emerged adult male; (H) pair of flies during copulatory induction behavior, (I) Same pair *in copula.* Bars = 1 mm.

Table 1. Ecological parameters (means) quantified for three host plants infested by third instars or puparia of *Dioxyna picciola*.

	Host Plant Species		
	C. bigelovii	*C.* sp. (small)	*C.* sp. (large)
Average:			
No. of individuals per flower head	3.5	3.5	2.57
(Range)	(1–11)	(1–10)	(1–6)
Receptacle diameter	6.3	5.1	7.05
Puparia length	2.79	2.54	2.68
Puparia width	1.01	1.04	1.04
Achenes per flower head	68.0	51.3	85.4
Achenes damaged per flower head	28.2	18.67	11.8
Achenes damaged per individual	8.13	5.33	4.6
Percentage:			
Achenes damaged per individual	42%	36%	14%

persists and attacked achenes are aborted. Again, in flower heads containing more than one second instar, each larva occupies a separate achene (Fig. 6D). The receptacles of flower heads are not scored by larvae in this instar (Fig. 6D).

Third instars feed head-downward and separately, each within an individual central achene. All of the achene contents are consumed before the larva begins to score the receptacle. Mature third instars score a shallow, circular depression in the receptacle and remain head-downward feeding on the plant sap that accumulates in each depression (Fig. 6E). Feeding depressions were observed only in the centers of the receptacles where third instars congregated for feeding. Feeding depressions were approximately 0.6–0.7 mm in diameter.

Coreopsis bigelovii is a native desert annual with a receptacle that averaged 6.3 ± 0.2 (range, 5.1–7.9; n = 15) mm in diameter, each head of which contained an average of 68 ± 2.1 (range, 50–80) achenes (Table 1). An average of 3.5 ± 0.7 (range, 1–11) larvae and puparia of *D. picciola* were found in 15 infested flower heads (7.5%) of 200 heads dissected. These larvae damaged 28.2 ± 4.7 (range, 12–60) achenes per head, or 8.1 achenes per larvae; 7 (49%) of these 15 infested heads had their receptacles scored, but only heads with >1 larvae. Twenty flower heads of the larger ornamental variety of *Coreopsis* averaged 7.1 ± 0.4 (range, 4.5–10.9) mm in receptacle diameter and each contained an average of 85.4 ± 9.6 (range, 50–185) achenes (Table 1). An average of 2.6 ± 0.3 (range, 1–6) larvae were found in 20 infested heads examined of this cultivar, 16 (73%) of which had their receptacles scored; these larvae damaged 11.8 ± 2.3 (range, 2–36) achenes per head or 4.6 achenes per larva. Eighteen (41%) of 44 smaller flower heads of the "Early Sunrise" variety of ornamental *Coreopsis* were infested; each head averaged 5.1 ± 0.2 (range, 4.0–8.0) mm in receptacle diameter and contained an average of 51.3 ± 3.4 (range, 35–75) achenes (Table 1). An average of 3.5 ± 0.6 (range, 1–10) individuals were found in infested flower heads, all of which had their receptacles scored. An average total of 18.7 ± 2.9 (range, 2–36) achenes were damaged in each head; an average of 8.1 achenes damaged per larva. The tephritid causes no eco-

nomic damage to ornamental *Coreopsis* in southern California because when oviposition occurs, the flower heads already are near or in full bloom and larval development occurs during flower head maturation, with most achenes left untouched, as documented above.

The receptacles of both ornamental varieties infested with single or multiple larvae were scored (Fig. 6E, F); therefore, the formation of feeding depressions was not density dependent as reported for *Paracantha gentilis* Hering in flower heads of native *Cirsium* thistles (Headrick and Goeden 1990). However, in the medium-sized flower heads of uncultivated *C. bigelovii,* only flower heads infested with two or more larvae showed feeding depressions. The centralized positions of the third instars, puparia, and feeding depressions of *D. picciola* (Fig. 6F) is found among some, but not all florivorous Tephritidae in southern California. This occurrence in the centers of flower heads was linked to resource sharing in the larger-size flowerheads of *Cirsium* thistles, within which Lepidoptera fed on the peripheral achenes (Headrick and Goeden 1990). Only larvae of *Trupanea jonesi* Curran occasionally shared the flower heads of *C. bigelovii* with *D. picciola* (Goeden 1985, 1992), except for one observation of a larva of an undetermined species of curculionid found feeding in the receptacle of a flower head that contained two third instars and a puparium of *D. picciola.*

Puparium.—Third instars began pupariation by turning 180° and facing away from the receptacle surface. Puparia were formed with their posterior ends resting in the shallow feeding depressions (Fig. 6F). In multiply-infested flower heads, the puparia were contiguous, clustered in the center of the flower head and covered by the dried remains of achenes, dried sap, pappus hairs, and frass (Fig. 6F). Third instars that did not score the receptacle also turned 180° from their feeding position head-downward in an individual achene and pupariated inside the hollowed out achene. In *C. bigelovii,* the achenes were much larger than the mature larva, and larvae that did not score the receptacle pupariated within the achene well above the level of the receptacle. In these instances, the basal fragment of the achene had acted as a conduit for the sap from the receptacle fed upon by the larva. In flower heads with multiple larvae, those that pupariated first were located centrally, followed later by the surrounding, peripheral larvae (Fig. 6F).

Adult.—Females emerge reproductively immature and showing few fat globules in their haemolymph. Their rudimentary ovarioles measured ca. 0.4 mm in length and females required ca. 3 weeks of feeding in the laboratory to mature eggs before mating and oviposition behaviors were expressed. Adults are long lived, with 12 females averaging 93.2 ± 7.22 (range, 49–203) d longevity in the laboratory, and 19 males (Fig. 6G) averaging 88.7 ± 4.5 (range, 62–129) d.

In laboratory mating trials adults were active from ca. 0900 to dusk. Both males and females rested, groomed, and fed within arenas and when observed in the field. Mating occurred throughout the day and into the night in laboratory arenas under artificial lighting, and with some pairs continuing in the dark under both the field and laboratory conditions.

Wing displays: Both sexes lofted their wings (*cf.* Goeden et al. 1994b, Headrick and Goeden 1995), but the wings were only raised slightly. Lofting in *D. picciola* involved extending both wings forward synchronously from the resting position in which both wings were held flat and slightly parted over the dorsum. Both wings were extended forward through ca. 20° and raised only slightly without any supination during extension. Both sexes also simultaneously raised their abdomens ca. 20° with each wing extension. The wing loft and abdominal flexure were concurrent and lasted ca. 1 sec. Lofting displays were observed while individuals were walking or while facing other individuals. Males also exhibited slight hamations over their abdomens

after such wing displays, similar to those reported for *Trupanea* spp. (Headrick and Goeden 1991, 1995). Thus, hamations followed lofting displays before the wings moved into a resting position. In the field, males exhibited wing displays during copulation and during encounters with other males; each of these displays is described below. Females were observed to exhibit slight asynchronous supinations when facing an intruder or other moving object as reported for many other tephritid species (Headrick and Goeden 1991, 1995). Females also displayed slight hamations after wing displays before returning their wings to a resting position.

Courtship: Twelve male-female encounters were observed in the laboratory in which males approached females in 7 of the 12 encounters. During all 12 approaches, both sexes displayed wing lofting coupled with abdominal raises, and on one occasion a male displayed abdominal pleural distension, but no other courtship or display behaviors were observed. Both sexes also visually oriented to the opposite sex as they passed each other in the arenas. Males oriented toward females, apparently visually, 8 times in one 2-h observation period and females oriented visually toward males twice in the same period. Females also raised their front legs toward advancing males, who then moved away (n = 2).

Courtship which led to mounting of the female by the male was observed twice in laboratory arenas, where the behaviors displayed by *D. picciola* were similar to those described for *Campiglossa genalis* (Goeden et al. 1994b). *Dioxyna picciola* males oriented toward females throughout the day in both field and laboratory observations; however, courtship was only observed in laboratory arenas (see Field Observations, below). During courtship males approached females head-on with their wings lofted, but raised higher than in the general lofting display described above. The wings were supinated ca. 45° and raised above the thorax ca. 70–80° from the horizontal. In one of the two courtship observations, the male approached a female and held his wings lofted and still. The female also stood still. He then expanded his abdominal pleura, extended his mouthparts, wagged them back and forth and raised his front legs over his head. The female did not move as the male next walked onto her dorsum, turned 180°, grasped her with his legs, and began copulatory induction behavior. In the other observation, the male lofted his wings, distended his abdominal pleura, wagged his extended mouthparts, then quickly climbed on top of the female without raising his front legs. A total of six mountings was observed; two followed courtship and four were opportunistic in which males mounted females contacted by chance movements within the arena and without prior displays. In the remaining male-female encounters, (n = 8), females decamped (n = 4), remained still (n = 1), or moved away, then returned to a male (n = 3).

Mounted males turned 180° and grasped the female with their front legs on the humerus of her thorax; the foretarsi rested behind the female's head. The middle legs grasped the thorax behind the wing bases and the hind legs rested on top of the abdomen. Copulatory induction behavior began from this position. In all mountings, copulatory induction behavior was initiated and copulation followed (n = 6), i.e. no female was observed to successfully reject a male once he mounted her.

Copulatory Induction Behavior (CIB): Mounted males began CIB by pulling upward on a female's abdomen with the hind legs. A mounted female raised her front legs above her head in an attempt to grasp the male. This was observed when a male's front tarsi touched the female's head, but did not occur when his tarsi remained on the female's thorax. All females groomed their abdomens vigorously with their hind legs just after being mounted. Mounted females spread their wings ca. 80° from the midlines of their bodies. Wing spreading was also observed after disengagement (see

below). The wings of males remained slightly overlapped during copulation. Females continued to resist mounted males and resisted having their abdomens pulled upwards. Mounted males displayed CIB different from other species of non-frugivorous tephritids examined thus far (Headrick and Goeden 1995). The hind tarsi of a mounted male were flattened against the dorsum of a female's abdomen, in a line parallel with the long axis of her body. Males rubbed their hind tarsi asynchronously against the first three abdominal tergites of the females, posteriorly to anteriorly, in rapid bursts that lasted 1–5 sec interspersed with pauses of 1–30 sec. CIB continued until a female raised her ovipositor and partly exserted the aculeus; no female was observed to be unresponsive to CIB (n = 17). Females responded by raising the ovipositor upward ca. 45° with respect to the abdomen (Fig. 6H). After the ovipositor was raised, the aculeus was exserted slightly, exposing its tip. Females continued to raise the abdomen and ovipositor unassisted until the ovipositor was perpendicular to the abdomen of the male (Fig. 6I). The male then released the female's abdomen and began vigorous CIB with the hind legs to further induce the female to hold her abdomen upward in the extended position. When females raised the ovipositor fully, males moved posteriad, extending their abdomens to engage the partially exerted tip of the aculeus with the surstylii (Headrick and Goeden 1995). This engagement was only successful on the first attempt in one of 17 observations. More often, the males missed engaging the aculeus and females lowered the abdomen and ovipositor to a resting position. This stimulated a male to continue with vigorous CIB and the female responded by again raising the ovipositor, partly exserting her aculeus, and then lifting her abdomen. The male then again extended his abdomen in an attempt to engage the raised ovipositor apex with his surstylii on the aculeus. If he was successful, he moved forward again and intromission began.

Copulation: Fourteen pairs were observed *in copula,* six of which were observed for the total length of their mating sequence. These 6 pairs repeated copulations an average of 3 times (range, 2–6) with the male remaining mounted on the female. Five pairs remained together an average of 6.2 (range, 4–8) h. One of the pairs remained together for total of 28 h! Single copulation events averaged 1.0 (range, 0.5–1.25; n = 19) h.

Copulation began with males successfully engaging the margins of the aculeus with the prensisetae of the surstyli (Headrick and Goeden 1995). Once engaged, females fully exserted the aculeus, thus raising the male's abdomen and exposing the cloaca of the aculeus. The aculeus was perpendicular to the long axis of the male's abdomen, as is typical of some *Campiglossa* spp. (Goeden et al. 1994b, Headrick and Goeden 1995). The aedeagus uncoiled and entered the ventral flap from behind and above. When the ventral flap opened, the distiphallus could be seen entering and moving down the aculeus, which caused the latter to expand. The eversible membrane also expanded as the distiphallus passed through it; therefore, the progress of aedeagal insertion could be monitored. The distiphallus entered the ventral flap and reached the oviscape in less than 1 sec (n = 2). Males pushed against the aculeus as the aedeagus was further inserted, while females simultaneously applied pressure on the aculeus against the male, which caused expansion of the eversible membrane. After ca. 2 min, males had fully inserted the aedeagus, and the epandrium rested against the margin of the partially exerted eversible membrane (n = 2). During copulation, females became agitated and males responded with CIB until they again were quiet. Males also displayed synchronous wing lofting when approached by other males while in copula, both in the field and laboratory arenas. The wings were held at ca. 45° away from the midline of the

body, slightly raised and supinated to ca. 45° with respect to the substrate.

Six disengagements were observed, three in the field and three in laboratory arenas. Females typically became agitated before disengagement, which began with partial extension of the aculeus. Males responded by raising their body and pushing downward on the dorsum of the female's abdomen with the hind legs. Males continued rubbing and pushing down on the female's abdomen, and females further exerted the aculeus. The aedeagus was withdrawn by actions of both the male and female. Males pulled the aedeagus free by raising the abdomen, while females lowered their abdomens, but kept the ovipositor flexed upward and the aculeus extended. Once free, males recoiled the aedeagus either with or without the use of the hind legs and females lowered their ovipositors. Grooming commenced immediately after disengagement. Males rested their hind legs on top of the female's abdomen, but continued to grasp the female with the front and middle legs.

Males initiated CIB after disengaging and pairs re-mated with the males never having moved off of the female. *Campiglossa genalis* also exhibited this type of mate-guarding behavior (Goeden et al. 1994b). In the field, *D. picciola* pairs disengaged and males remained on females while they oviposited into flower heads, after which CIB was initiated and copulation occurred at least once again (n = 6). In laboratory arenas, males remained on females and soon initiated CIB without the females having oviposited. Both *D. picciola* and *C. genalis* display prolonged contact in which males remain on the dorsa of females after removal of the aedeagus (Goeden et al. 1994b, Headrick and Goeden 1995). CIB is typically initiated again and copulation follows. Copulations are repeated from 2-7 times in individual mating episodes.

Waste elimination: Waste elimination by males was typical for other tephritids examined thus far (Headrick and Goeden 1995). However, females exserted the aculeus, placing the tip onto the substrate, formed a subapical waste droplet from the cloaca onto the substrate, then retracted the aculeus without dragging it and thus left behind a small droplet.

Defense: Females raised the front legs toward approaching individuals in a defensive posture (n = 2) and both sexes displayed asynchronous wing supination extensions toward moving objects. Males did not raise the front legs in defense.

Territoriality: Males displayed aggression toward each other in the field, but no specific territorial displays or behaviors were observed.

Field observations: Distribution and abundance. Only one to five adults were observed at any one time on or near their individual host plants. Mating pairs were first observed after at least some of the flower heads had opened. Prior to flowering, individuals were observed resting singly, head-down on peduncles or leaves, or exploring the immature flower heads. Females did not probe the immature heads with their ovipositors. Pairs in copula were observed on peduncles, leaves and flower heads in all stages. Mated females moved from one head to another by flying short distances with males still mounted on their dorsa, but females did not move among flower heads while in copula. Adults remained on their host plant for feeding, resting, grooming, copulation and oviposition. Adults remained on the upper portions of plants until after dusk, but then were not observed on plants until the next morning. Presumably, they moved down into the centers of crowns during the night. Adults of *D. picciola* were never abundant; a maximum of five was observed on any one plant.

Male–female interactions: Individual males rested on peduncles, leaves and flower heads visually scanning the plant. Females were observed commonly on the tops or the undersides of flower heads, as well as on leaves and peduncles. Males encountered females only on flower heads (n = 6).

Courtship was not observed and females usually took flight when approached by males.

Three mated pairs were observed during field observations. The three pairs rested on different parts of the plant while in copula, but most commonly on flower heads. Females walked on flower heads continuously while in copula. Males in copula displayed their wings when approached by other individuals or when the females became agitated. Males spread their wings to ca. 45° from the midline of the body and vibrated them forward for ca. 1 sec, keeping them horizontal to the substrate, then returned them to their resting position. Wing displays were continued until the female became quiet or the other intruding individual moved away.

Oviposition.—When a pair disengaged, the male remained on top of the female and she began to explore the centers of blossoms for oviposition. Females also spread their wings to ca. 90° from the midline of the body without supination after disengagement, while searching and probing for oviposition sites. During oviposition, (n = 8), a female bent her abdomen downward, exserted her aculeus in between the outer florets and ray flowers and deposited her eggs singly. Males, with difficulty, remained mounted on females during oviposition. Males groomed while females probed and oviposited. Females groomed after oviposition. Males resumed CIB after females probed flower heads (n = 2), or after one to three eggs were laid (n = 3), or after the female moved to a new flower head (n = 1), usually within ca. ½ h of disengagement. One pair stayed together for 28 h, during which time they copulated and oviposited three times in one day, remained *in copula* on one flower head overnight, and copulated and oviposited again three times during the following day.

Grewal and Kapoor (1984) described the courtship and mating behaviors of *D. sororcula* on *Callendula officinalis* in India in the field and laboratory. They described the floral discs of flower heads of *C. officinalis* as "sites of assembly" on which 93% of male-female encounters took place. Copulations were attempted in 53% of all encounters and 91% were successful. They also described aggressive behavior between adults involving synchronous wing supinations, front leg elevations, and charging behaviors similar to those limitedly observed in the present study. However, certain differences in the courtship and copulation behaviors of these geographically disparate populations were evident. For example, Grewal and Kapoor (1984) did not report male courtship displays, only that males rapidly mounted ovipositing females. Grewal and Kapoor (1984) also reported that mounted males did not show any wing displays when approached by other males; however males in both the field and laboratory settings displayed their wings at intruders. In the present study, courtship displays were observed in the laboratory, and unlike *D. sororcula* in India, males did not mount females while they were ovipositing. Grewal and Kapoor (1984) reported that males copulated with females an average of four times during a single mating episode and that between copulations females laid 2–5 eggs singly. We similarly observed three copulations per mating episode and 1–3 eggs laid between copulations, but again, no males mounting ovipositing females. Grewal and Kapoor (1984) also reported that pheromones were not involved in courtship or copulation and that conspecific recognition was by vision only. In the present study, abdominal pleural distension was observed, and thus, pheromone mediated behavior cannot be entirely dismissed (Headrick and Goeden 1995). Grewal and Kapoor (1984) also did not report the CIB described above, which uniquely involved mounted males: rubbing the tops of female's abdomens with their hind tarsi; instead, they reported CIB involving male mouthpart pumping and repeated touching inner vertical and postvertical bristles of the female, to which she responded by pumping

her mouthparts for 10–30 seconds, then jerked her head upward while elevating her ovipositor. They also observed that the mounted male cleaned his legs and head, and the female while mounted cleaned her wings, head, and legs before initiating CIB and achieving intromission.

Seasonal history.—*Dioxyna picciola* can be designated a "late aggregated attacker" among the trophic strategies proposed by Zwölfer (1988). In southern California, wild *Coreopsis* spp. begin flowering in the spring (April–May) and this continues through the summer months (June–August) on cultivated varieties. F_2 adults produced on *Coreopsis* and F_3 adults produced on *Bidens* and overwintered from the previous year, aggregate on newly-flowering *Coreopsis* for mating and oviposition in the late spring and early summer (April–June). Development of the larval stages is completed in ca. 3 weeks, pupariation occurs, and adults emerge ca. 2 weeks later. Some of these adults continue reproduction on their host plants if they are still in bloom, e.g. ornamental *Coreopsis,* and produce a second generation in the late summer (July–August). The F_2 adults emerge by the fall (September) to disperse to other locales where alternate host plant species such as *Bidens* spp. are in bloom to reproduce an F_3 generation, or to overwinter until the following season.

Natural enemies.—The following chalcidoid Hymenoptera were reared from puparia as primary, solitary, larval-pupal endoparasitoids: *Eurytoma* sp. (Eurytomidae) and *Halticoptera* sp. (Pteromalidae).

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A REVIEW OF THE SPECIES OF THE GENUS *MUCRENCYRTUS* NOYES (HYMENOPTERA: ENCYRTIDAE)

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Abstract.—The New World encyrtid genus *Mucrencyrtus* is redescribed, and the species are reviewed. Five new species, ***M. arundinariae,*** n. sp., ***M. atratus,*** n. sp., ***M. dbari,*** n. sp., ***M. ecuadorensis,*** n. sp., and ***M. variabilis,*** n. sp. are described and illustrated. A key to species is provided.

Key Words: Hymenoptera, Encyrtidae, *Mucrencyrtus,* New World, key to species, new species

The encyrtid genus *Mucrencyrtus* was described by Noyes (1980) in his review of the genera of Neotropical Encyrtidae. Originally three species, all from the Neotropics, were included in the genus - *Mucrencyrtus insulanus* Noyes (type species), *M. aclerdae* (De Santis) (transferred from *Aenasioidea*) and "an undetermined species from Ecuador". Recently, the first North American species, *M. ferrierei* (Burks), was transferred to *Mucrencyrtus* from *Aenasioidea* (Noyes and Woolley 1994).

In the material reared by the author from *Aclerda* sp. aff. *arundinariae* McConnell collected on cane *Arundinaria tecta* (Walter) Muhlenberg in Georgia (USA), a new species of *Mucrencyrtus* was discovered. The species did not correspond to the original description of the genus because both female and male had a greatly broadened and flattened antennal scape—a feature not possessed by the species upon which the original description was based. A study of additional material from North, Central and South America revealed five other new species of *Mucrencyrtus* (including the one referred to by Noyes (1980) as "an undetermined species from Ecuador"), as well as one further undetermined species from Uruguay known only from male. Therefore, nine species are recognized in this paper. New species are described and a key to species is provided.

MATERIALS AND METHODS

Measurements were taken with a stereomicroscope equipped with a filar micrometer 15× eyepiece with a graduated knob. At the microscope magnification changer set at ×50, the rotation of one numbered division of the knob corresponded to 0.01 mm. The measurements in parentheses in the descriptions are given in units of the micrometer: an absolute value of one unit is 0.01 mm. All measurements are comparable and can be translated into millimeters by multiplying the number of units by 0.01.

Measurements were taken as shown in Figs. 3–6. I call "length" all the measurements taken along the longitudinal axis of the body, "width"—the measurements taken along the transverse axis, and "height"—the measurements taken along the vertical axis of the body.

Head length—maximum length of the head measured laterally or from above. (I

usually took both measurements to make sure that they gave the same result).

Head width—maximum width of the head measured from above or in frontal view (usually, both measurements were taken).

Head height—maximum height of the head measured in frontal or lateral view (usually, both measurements were taken).

Width of frontovertex was measured at the level of the anterior ocellus in dorsal or frontal view.

POL—postocellar line, the minimum distance between the posterior ocelli.

OOL—ocular-ocellar line, the minimum distance between the posterior ocellus and eye orbit.

LOL—lateral ocellar line, the minimum distance between posterior and anterior ocellus.

OCL—ocellar-occipital line, the minimum distance between posterior ocellus and occipital margin.

Anterior angle of ocellar triangle (α) was calculated as follows: $\alpha = 2 \arcsin POcL/2\ LOcL$, where POcL is the distance between centers of posterior ocelli, and LOcL is the distance between centers of posterior and anterior ocelli.

Eye length—maximum length of the eye measured in dorsal view.

Temple length—maximum length of the temple measured in dorsal view.

Eye height—maximum height of the eye measured in frontal view.

Eye maximum and minimum diameters were measured with the plane of the eye orbit perpendicular to the optic axis.

Distances between antennal toruli, antennal torulus and eye orbit, and antennal torulus and mouth margin are minimum distances taken in frontal view.

Malar space—minimum distance between the eye margin and the margin of the buccal cavity measured along malar sulcus (in this case the measurement was taken in frontal view).

Mouth width—maximum width of the buccal cavity measured in frontal view.

Length and width of antennal scape are maximum measurements along longitudinal and transverse axes of the scape without radicle.

Length of mesosoma—distance from anterior margin of the pronotum to the posterior margin of the propodeum.

Width of mesosoma, length and width of mesoscutum and of scutellum, length and width of metasoma, are maximum measurements taken with the optical axis perpendicular to the plane of the measured bodypart.

Distance from base of metasoma to pygostyli and from pygostyli to apex of metasoma are the measurements taken from above, between the center of the cercal plate and anterior and posterior ends of the metasoma. In some critical-point-dried specimens the metasoma was overinflated, and the distances and proportions distorted. Such specimens were not used for relative measurements.

Length of ovipositor—length of exerted part of the ovipositor.

Terminology for the sculpture follows Gibson (1989).

Drawings were made from slide mounted material using a camera lucida with a compound microscope with phase contrast attachment.

Abbreviation for depositories of type materials are: AMNH (American Museum of Natural History, New York, NY, USA), CNCI (Canadian National Collection, Ottawa, ON Canada), BMNH (Natural History Museum, London, UK), MLP (Facultad de Ciencas Naturales y Museo, La Plata, Argentina), OSUC (Ohio State University, Columbus, OH, USA), TAMU (Texas A&M University, College Station, TX, USA), USNM (National Museum of Natural History, Smithsonian Institution, Washington, DC, USA).

Mucrencyrtus Noyes

Mucrencyrtus Noyes, 1980: 213–214. Type species: *M. insulanus* Noyes, by original designation.

Comments.—Because the original description was based only on three species, some of the characters used as generic features have proved to be of only specific value, and some features of generic value were not included in the description. These features, with necessary changes, are described below.

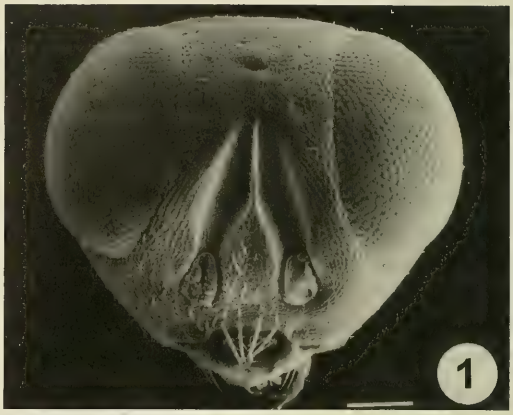
Head: Eye reaching occipital margin, or separated from the latter by the distance up to ⅓ eye length (dorsal view). Malar space from less than ½ to ⅔ maximum diameter of eye; malar sulcus from weakly indicated to well expressed. Frontovertex at narrowest point ⅖–⅗ head width, ocelli forming from slightly acute- to obtuse-angled triangle, posterior ocellus separated from eye orbit by distance equal to ½–2 ocellar diameters. Scape subcylindrical to greatly broadened and flattened. Clava with apex rounded or very slightly obliquely truncate.

Mesosoma: Notaular lines very slightly indicated, almost absent, to well developed anteriorly. Scutellum flat to very slightly convex, with apex pointed and produced posteriorly as a very narrow translucent flange, the latter sometimes very weakly expressed and inconspicuous. Wings in both sexes from fully developed to rudimentary, with transitional forms. In micropterous forms forewing rudiments with rounded, truncate, or pointed apex.

Metasoma: Apical extension of hypopygium reaching, or almost reaching, apex of metasoma.

Diagnosis.—The genus can be readily recognized by a combination of two characters—the shape of the interantennal prominence, which is produced in its upper part as a long, sharp, narrow ridge (Fig. 1), and the shape of the hypopygium, which is produced posteriorly into a long, narrow extension reaching, or almost reaching, the apex of the metasoma (Fig. 2).

Biology of species.—All species for which the biology is known were reared from coccoids of the family Aclerdidae (Homoptera: Coccoidea), where they apparently develop as primary parasitoids.



Figs. 1, 2. *Mucrencyrtus arundinariae,* female. 1, Head, frontal view. 2, Metasoma, ventral view.

Distribution of species.—Representatives of the genus are known only from the New World, occuring in both North and South America.

Systematic position.—Although Noyes (1980) did not directly place *Mucrencyrtus* in any of the tribes of Encyrtidae according to Trjapitzin's (1973a, b) classification, he stated that it is very close to *Allencyrtus* Annecke & Mynhardt (tribe Microteryini, subtribe Microteryina). However, some fea-

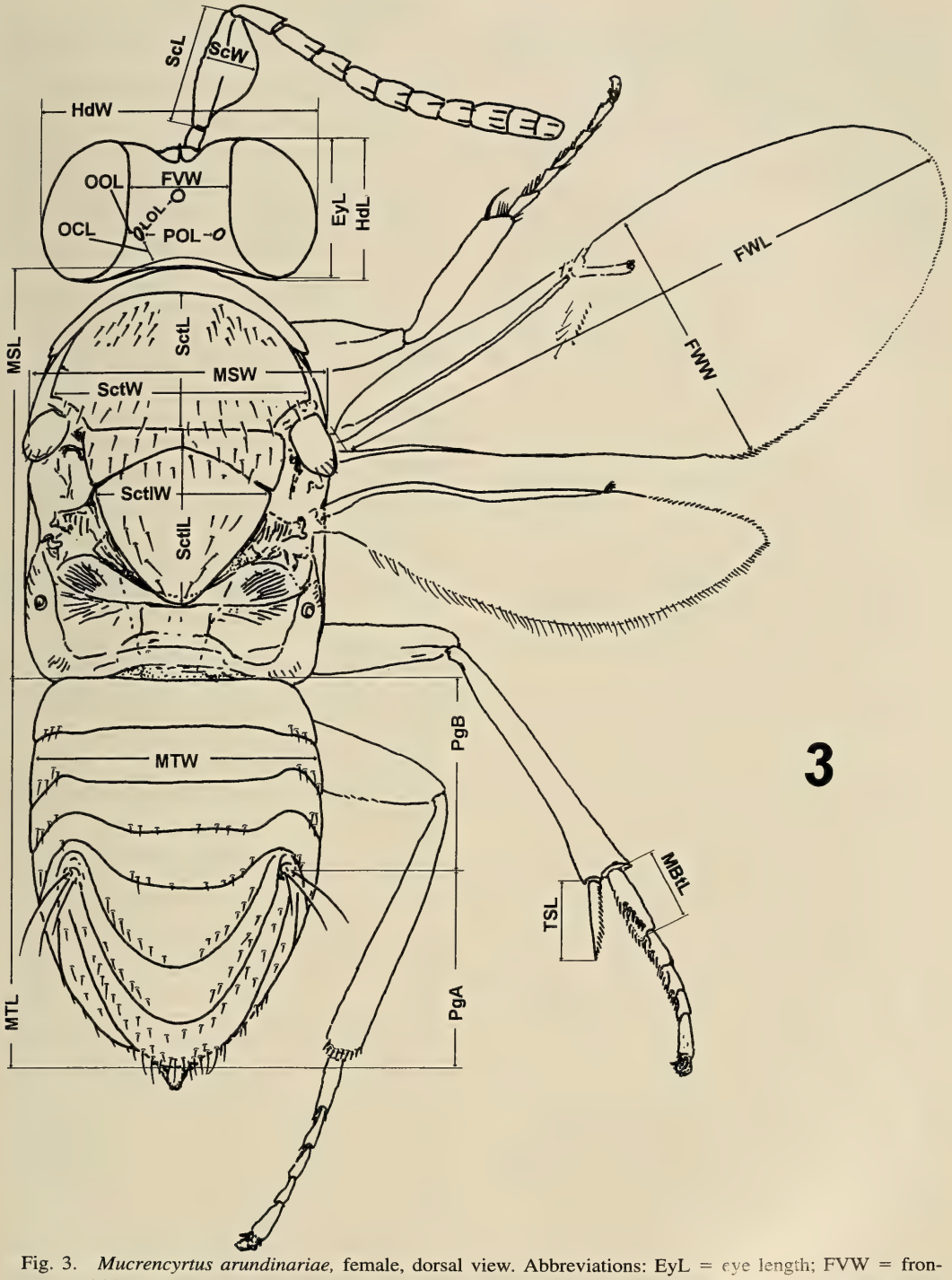


Fig. 3. *Mucrencyrtus arundinariae,* female, dorsal view. Abbreviations: EyL = eye length; FVW = frontovertex width; FWL = forewing length; FWW = forewing width; HdL = head length; HdW = head width; LOL = lateral ocellar line; MBtL = mid basitarsus length; MSL = mesosoma length; MSW = mesosoma width; MTL = metasoma length; MTW = metasoma width; OCL = ocellar-occipital line; OOL = ocellar-ocular line; PgA = distance from pygostyli to apex of metasoma; PgB = distance from pygostyli to base of metasoma; POL = postocellar line; ScL = antennal scape length; SctL = scutum length; SctlL = scutellum length; SctlW = scutellum width; SctW = scutum width; ScW = antennal scape width; TSL = midtibial spur length.

tures of *Mucrencyrtus*, such as the presence of notauli and the hypopygium reaching the apex of the metasoma, do not correspond to Trjapitzin's definition of the tribe Microteryini. These features, however, agree with those of the tribe Aphycini. Weakly expressed sexual dimorphism, and absence of metallic shine, even in dark-colored species are also characteristic of most of the representatives of Aphycini. Therefore, I am inclined to include the genus *Mucrencyrtus* in the tribe Aphycini, subtribe Paraphycina, although I am not absolutely sure as to the correctness of this placement.

Key to Species

1. Head and body completely very dark brown, or black, except for apex of scutellum, which is brownish orange, and anterolateral corners of propodeum, which are white; fore coxa brown to dark brown, about same color as mid and hind coxae . . . . . *Mucrencyrtus atratus,* n. sp.
– At least head orange or yellow; fore coxa white to orange yellow, same color as or lighter in color than mid and hind coxae . . 2
2(1). Wings normal; forewing reaching beyond apex of metasoma 3
– Wings shortened or rudimentary; forewing not reaching apex of metasoma, often only reaching base of metasoma 9
3(2). Scape subcylindrical or slightly to moderately broadened and flattened, its length not less than 2.5 times maximum width 4
– Scape strongly broadened and flattened, its length 1.8 to 2.2 times maximum width (Fig. 27) . . . *Mucrencyrtus arundinariae,* n.sp.
4(3). Forewing hyaline or very slightly, uniformly suffused with yellow 5
– Forewing with large dark central spot (Fig. 31) 8
5(4). Gena with brown to dark-brown spot or oblique stripe, sometimes weakly expressed (Figs. 7, 8) . . . *Mucrencyrtus variabilis,* n.sp.
– Gena unicolorous, whitish yellow to orange yellow, without dark spot or stripe 6
6(5). Scape length about 3 times, or slightly less, its maximum width . . . . . *Mucrencyrtus ferrierei* (Burks)
– Scape length more than 3 times its maximum width 7
7(6). Mesopleuron same color as rest of mesosoma; axilla with dark edges and corner adjacent to central axis of body; ocelli form an obtuse-angled triangle (Fig. 6) . . . . . *Mucrencyrtus variabilis,* n.sp.
– Mesopleuron, especially in its posterior part, darker than rest of mesosoma; axilla unicolorous, without dark edges; ocelli form a right triangle . . . . . *Mucrencyrtus ecuadorensis,* n.sp.
8(4). Head same color as mesosoma, yellow or slightly brownish yellow; distance between toruli less than 1.5 times distance between torulus and eye orbit; scape about 3 times as long as broad . . . . . *Mucrencyrtus aclerdae* (De Santis)
– Head orange yellow, lighter than largely dark-brown mesosoma; distance between toruli more than 2 times distance between torulus and eye orbit; scape very slightly more than 2.5 times as long as broad (Fig. 17) . . . . . *Mucrencyrtus dbari,* n.sp.
9(2). Scape about 3 times as long as broad; scutellum with sculpture similar to one of mesoscutum . . . . . *Mucrencyrtus ferrierei* (Burks)
– Scape more than 3 times as long as broad; scutellum with sculpture finer and deeper than one of mesoscutum . . . . . *Mucrencyrtus insulanus* (Noyes)

Mucrencyrtus aclerdae (De Santis)

Aenasioidea aclerdae De Santis, 1972: 18. Holotype female, Brazil (MLP) (not examined).

Mucrencyrtus aclerdae: Noyes, 1980: 215.

Distribution.—Brazil (Alagoas, Bahia, São Paulo).

Hosts and biology.—Reared from *Aclerda campinensis* Hempel on *Saccarum officinarum* L. (De Santis 1972), and from *Aclerda* sp.

Comments.—I have examined 3 females and 2 males of this species identified by J.S.Noyes, and 1 female identified by me. All of them have white anterolateral corners of the propodeum (adjacent to hindwing base and anterior to spiracle)—a feature not indicated by De Santis (1972). One female and both males have the anterior margin of the mesoscutum darkened (dark brown). The posterior margin of the mesopleuron is brownish white in 5 specimens (all except one female). In one female the base of the scape is yellow, the same color as its apical part. Other features agree with the original

description, and there is no doubt that these specimens belong to *M. aclerdae.*

Mucrencyrtus arundinariae Sharkov, New Species

(Figs. 1–4, 27–30, 32)

Female (holotype measurements in parentheses).—Body length 1.3–2.4 (1.9) mm.

Relative measurements.—*Head* width 1.82–1.9 times head length and 1.26–1.36 times head height (68:38:54). Frontovertex width at level of anterior ocellus 0.37–0.42 times width of head (26:68). Ocelli in very slightly acute or right triangle, with an angle at anterior ocellus of 82°–90°. POL: OOL:LOL:OCL = 17:1.5:11.5:7 (in holotype). OOL approximately ½ diameter of posterior ocellus (1.5:3.3). Distance between antennal toruli 1.0–1.3 times distance between antennal torulus and eye orbit, and 1.33–1.86 times distance between torulus and mouth margin (12:10:9). Malar space 0.62–0.69 times mouth width and 0.45–0.5 times eye height (18:26:36). Eye oval, maximum diameter 1.15–1.3 times minimum diameter (39:30). Posterior orbit of eye reaching, or almost reaching, occipital margin (dorsal view). Antenna as in Fig. 27. Scape strongly broadened and flattened, length 2.08–2.2 times maximum width (24:11).

Mesosoma length 1.18–1.31 times width (73:60). Mesoscutum width 1.84–2.0 times length (60:30). Scutellum length approximately equal to width (34:34). Mid tibial spur 0.75–0.91 as long as mid basitarsus and 0.25–0.3 as long as mid tibia (16:19:59). Forewing as in Fig. 32. Forewing length 2.4–2.57 times maximum width (136:53).

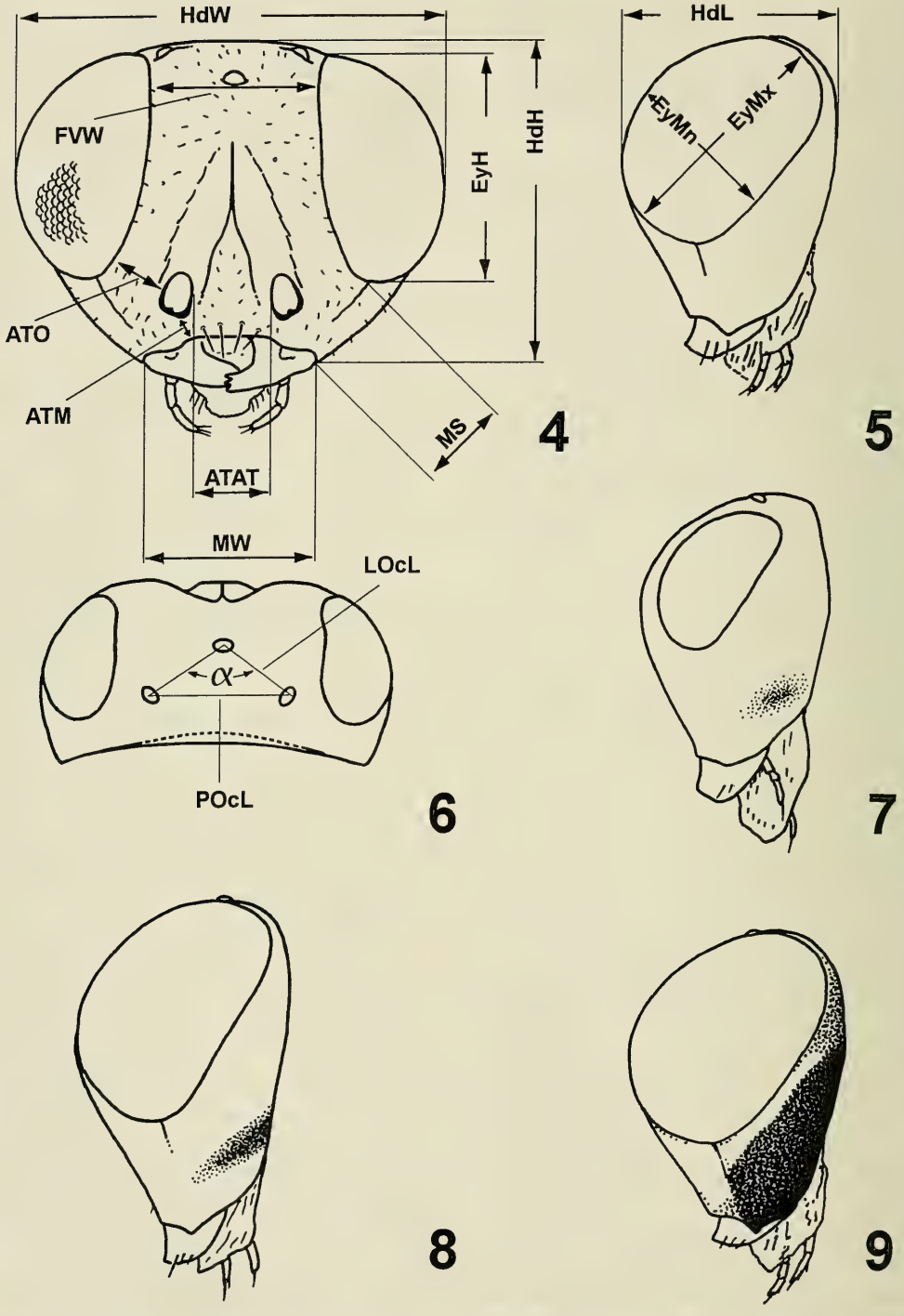
Metasoma length 1.1–1.26 times width (83:66). Distance from pygostyli to base of metasoma 0.5–0.53 times corresponding distance to apex of metasoma (29:54). Hypopygium as in Fig. 28.

Color.—*Head:* Frontovertex orange yellow or yellow orange. Face largely yellow, lighter, almost whitish yellow, in lower part, and gradually becoming yellow and orange yellow in upper part. Gena and occiput yellow, lighter than frontovertex; occiput with small dark-brown spot just above occipital foramen and with brown edges of foramen. Antenna with radicle yellow; scape very dark brown, almost black, with yellow base and apex (as in Fig. 27); pedicel dark brown, with yellow outer surface, except for brown base; funicle and clava dark brown, except for apex of clava, which is whitish light brown. Mandibles yellow basally and brown apically.

Mesosoma: Pronotum orange yellow, with brown area on that part of collum concealed by occiput. Mesoscutum, scutellum and axillae orange yellow or yellow orange; mesopleuron orange yellow, slightly lighter than mesoscutum and scutellum. Forewing very slightly infuscated in central part (Fig. 32), sometimes almost completely hyaline. All legs completely yellow. Metanotum dark brown, except central part light brown. Propodeum yellow laterally, dark brown dorsally, except for light-brown central part.

Metasoma: Brown to dark brown dorsally, with darkest coloration in central part, gradually becoming lighter toward sides and apex; its lateral and ventral parts brownish orange yellow.

Sculpture and pubescence.—*Head* (Fig. 1): Frontovertex shallowly reticulate, with sparse scattered punctures; elements of sculpture (cells) isodiametric, except for area between posterior ocelli and occipital margin where cells are transverse. Face shallowly reticulate, with cells isodiametric on interantennal prominence, and vertically elongate between antennal scrobe and eye orbit. Gena almost smooth, very shallowly reticulate, with vertically elongate cells and very shallow, inconspicuous scattered punctures. Head almost hairless, with scattered, inconspicuous, short translucent hairs on frontovertex and face, slightly denser setae on lower part of face, and with few longer yellowish-brown translucent hairs on clypeus.



Figs. 4–9. Heads of females. 4, 5, *Mucrencyrtus arundinariae.* 4, Frontal view. 5, Lateral view. 6–8, *M. variabilis.* 6, Dorsal view. 7, Lateral view of small-eyed specimen. 8, Lateral view of normal-eyed specimen. 9, *M. dbari,* lateral view. Abbreviations: ATAT = distance between antennal toruli; ATM = distance between antennal torulus and mouth margin; ATO = distance between antennal torulus and eye orbit; EyH = eye height; EyMn = eye minimum diameter; EyMx = eye maximum diameter, FVW = frontovertex width; HdH = head

Mesosoma: Collar of pronotum, mesoscutum, scutellum and axillae very shallowly reticulate, with cells slightly transverse in anterior ½ of mesoscutum, and more or less isodiametric in its posterior ½ and on axillae and scutellum; all with appressed dark-brown setae. Metanotum transversely rugulose, except for very shallow transverse reticulate central part. Mesopleuron very minutely shallowly reticulate, with cells slightly elongate anteriorly, more or less isodiametric medially, and very slightly elongate posteriorly. Dorsum of propodeum with few rugulae laterally.

Metasoma dorsally with very shallow reticulate sculpture, with slightly transverse cells, especially so in basal part, almost hairless; ventrally with brownish translucent hairs (Fig. 2).

Male.—Body length 1.4–2.0 mm.

Relative measurements.—*Head* width 1.92–2.0 times head length and 1.26–1.34 times head height. Frontovertex width at level of anterior ocellus 0.46–0.48 times width of head. Ocelli in right or very slightly acute or obtuse triangle, with angle at anterior ocellus of 88°–95°. POL:OOL: LOL:OCL = 16:1.5:10:5. Distance between antennal toruli approximately equal to distance between antennal torulus and eye orbit, 1.67–1.80 times distance between torulus and mouth margin. Malar space 0.74–0.91 times mouth width and 0.61–0.71 times height of eye. Eye oval, maximum diameter 1.26–1.41 times minimum diameter. Posterior orbit of eye reaching, or almost reaching, occipital margin (dorsal view). Antenna as in Fig. 29. Scape strongly broadened and flattened, length 1.77–2.11 times maximum width.

Mesosoma length 1.3–1.39 times width. Mesoscutum width 1.62–1.87 times length. Scutellum length approximately equal to width. Mid tibial spur 0.75–093 as long as mid basitarsus. Forewing length 2.34–2.5 times maximum width.

Metasoma length 1.18–1.3 times width. Pygostyli situated closer to base than to apex of metasoma (in critical-point-dried specimens with overinflated metasoma they may appear to be closer to apex of metasoma). Genitalia as in Fig. 30.

Color, sculpture and pubescence similar to those in female, except as follows. Scape very dark brown, almost black, with yellow base and apex, and brownish-yellow upper edge (pattern as in Fig. 29); pedicel yellow with dark brown base; flagellum brown, lighter than in female. Occiput with part touching collum of pronotum and corresponding part of collum very dark brown. Base (in one specimen—basal ½) of mesoscutum dark brown. Sometimes base of axillae brown, and scutellum rarely with brown spot in basal part in middle.

Hosts and biology.—Reared from *Aclerda* sp. aff. *arundinariae* McConnell (Homoptera, Coccoidea: Aclerdidae) on giant cane *Arundinaria tecta* (Walter) Muhlenberg.

Associated species.—Two other species of Encyrtidae were reared simultaneously with *M. arundinariae* sp. n.—*Comones ferrierei* (Burks) and *Cheiloneurus* sp. The former species is, probably, a primary parasite of Aclerdidae, while the latter one is a hyperparasite on either *M. arundinariae* sp. n. or *C. ferrierei.*

Material examined.—*Holotype* female: USA, Georgia, Liberty Co., St. Catherines Island, 7–12.viii. 1991, A. Sharkov, from *Aclerda* sp. aff. *arundinariae* on *Arundinaria tecta* (AMNH). Paratypes: same data, 6 females, 4 males (1 male in microslide # OSU-0002); same data, on *Arundinaria tecta,* sweeping, 3 females, 1 male (1 female

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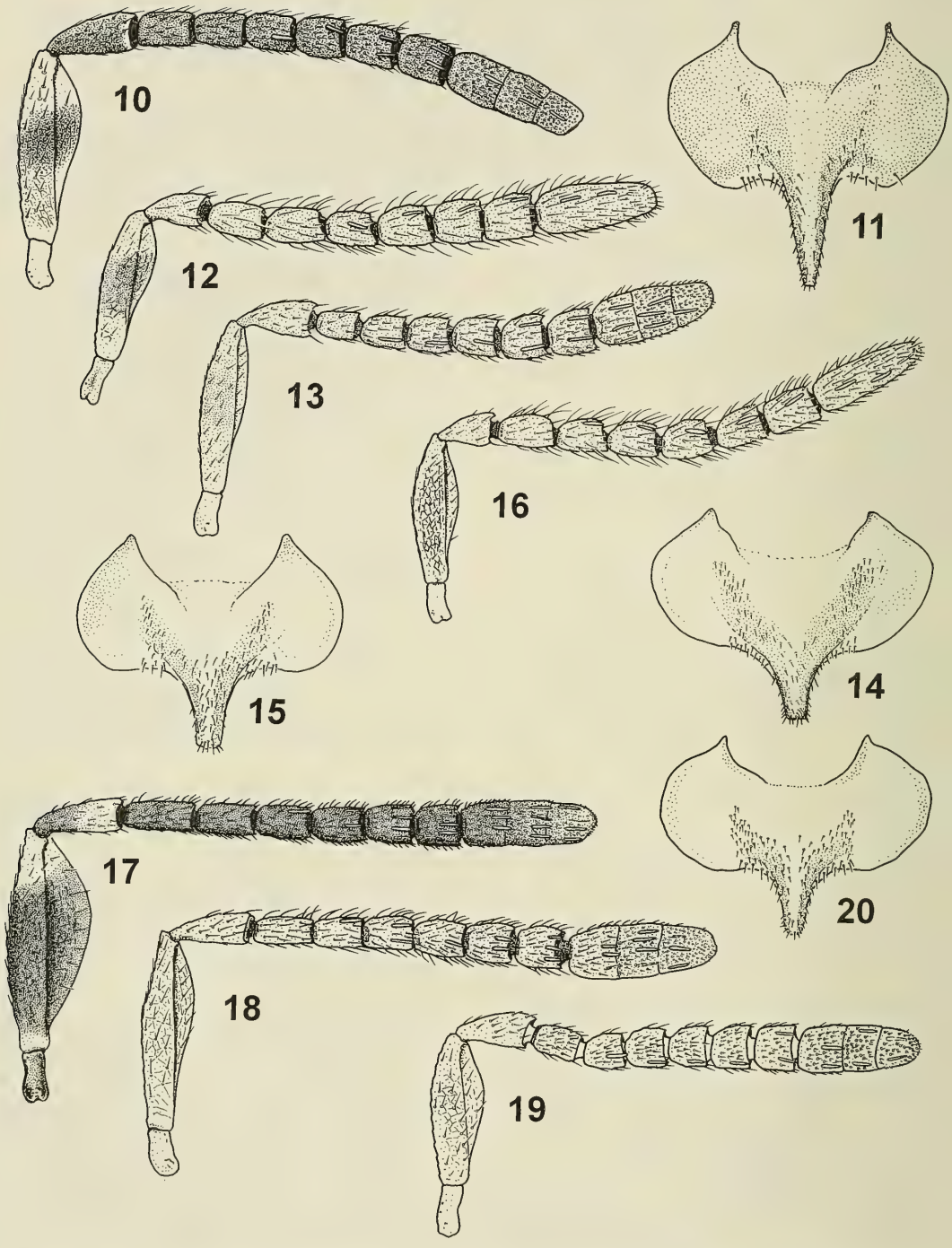
height; HdL = head length; HdW = head width; LOcL = distance between centers of anterior and posterior ocelli; MS = malar space; MW = mouth width; POcL = distance between centers of posterior ocelli; α = anterior angle of ocellar triangle.



Figs. 10–20. 10–12, *Mucrencyrtus* sp. aff. *ferrierei.* 10, Female antenna. 11, Female hypopygium. 12, Male antenna. 13–16, *M. variabilis.* 13, Female antenna. 14, Female hypopygium of small-eyed specimen. 15, Female hypopygium of normal-eyed specimen. 16, Male antenna. 17, *M. dbari,* female antenna. 18, *M. ecuadorensis,* female antenna. 19, 20, *M. ferrierei.* 19, Female antenna. 20, Female hypopygium.

in microslide # OSU-0001; another female was used for SEM, its antennae, wings and legs in microslide # OSU-0003); same location, 10–15.v.1991, A. Sharkov, 3 females, 2 males; same location, 31.v–3.vi.1991, A. Sharkov, 1 female; same location, from *Aclerda* sp. aff. *arundinariae* on *Arundinaria tecta,* 1–3.vi.1992, A. Sharkov, 3 females, 3 males; same data, 1–4.iv.1994, E. Quinter, 2 females, 2 males; same data, 16–19.iv.1994, 1 male; same data, 6–10.iv.1995, A. Sharkov, 5 females, 4 males (Paratypes in AMNH, BMNH, CNCI, and OSUC).

Distribution.—USA (Georgia).

Etymology.—The name derives from *Arundinaria*—the name of a host plant for a coccoid from which the new species was reared.

Diagnosis.—From other species of *Mucrencyrtus* differs by the greatly broadened and flattened scape of both females and males. From *M. dbari,* sp. n., which also has a broadened scape, *M. arundinariae,* sp. n. differs in coloration of head and body, and absence of a dark central spot on the forewing. Males also differ from all other species of *Mucrencyrtus,* for which males are known, in having digital sclerites with 3 claws (all others have 2—as in Fig. 26).

Mucrencyrtus atratus Sharkov, New Species
(Figs. 22–26)

Female (holotype measurements in parentheses).—Body length 1.44–1.78 (1.78) mm.

Relative measurements.—*Head* width 1.76–2.09 times head length and 1.25–1.35 times head height (62:35:46). Frontovertex width at level of anterior ocellus 0.36–0.4 times width of head (24:62). Ocelli in right, or very slightly acute or obtuse triangle, with angle at anterior ocellus of 88°–94°. POL:OOL:LOL:OCL = 15:1.5:10:7 (in holotype). OOL 0.37–0.5 times diameter of posterior ocellus (1.5:4). Distance between antennal toruli (in paratype) 1.44 times distance between antennal torulus and eye orbit and 1.73 times distance between torulus and mouth margin. Malar space (in paratype) 0.63 times mouth width and 0.46 times height of eye. Eye oval, maximum diameter 1.23–1.31 times minimum diameter (37:30). Posterior orbit of eye reaching, or almost reaching, occipital margin (dorsal view). Antenna as in Fig. 22. Scape very slightly broadened and flattened, length 3.13–3.33 times maximum width (22:7).

Mesosoma length 1.2–1.3 times width (72:60). Mesoscutum width 1.73–2.18 times length (60:30). Scutellum length equal to or slightly less than width (30:30). Mid tibial spur 0.83–0.94 as long as mid basitarsus and 0.29–0.3 as long as mid tibia (15:18:51). Forewing length 2.35–2.8 times maximum width (120:51).

Metasoma length equal to, or greater than width (68:58). Distance from pygostyli to base of metasoma 0.55–0.7 times corresponding distance to apex of metasoma (24:42). Hypopygium as in Fig. 23.

Color.—*Head:* Frontovertex very dark brown, almost black; face very dark brown, with interantennal prominence almost black, slightly lighter (dark brown) between antennal scrobe and eye margin toward mouth margin; gena very dark brown, almost black, slightly lighter in lower part; occiput very dark brown, almost black. Antenna with radicle brown with very dark brown upper surface; scape with whitish-light-brown base, very dark brown, almost black upper surface, except for apical ¼ or so, yellowish-brownish-white lower surface, except for very edge in basal ⅔, and yellowish-brownish-white apex; pedicel brown, with light-brown apex and dark-brown upper surface; funicle and clava brown. Mandibles brown, with apical part dark brown.

Mesosoma: Pronotum and mesoscutum black, or very dark brown; scutellum black, in posterior ¼ gradually becoming lighter toward apex, which is brownish orange yellow. Metanotum very dark brown, with median part brownish orange yellow, concolorous with apex of scutellum. Propodeum

dorsally very dark brown, except median part, which is yellowish light brown, and with white anterolateral corner (adjacent to hindwing base and anterior to spiracle). Sides of mesosoma dark brown. Tegula very dark brown. Forewing infuscated in middle part (similar to Fig. 31), and with basal ¼ or so of submarginal vein and setae in basal part of wing (proximad of fuscous spot) whitish, very light colored. Hindwing with whitish submarginal vein and setae in basal part. Coxae of all legs dark brown, with lighter brown apex. Fore femur brown, gradually becoming lighter toward apex, which is yellowish light brown; fore tibia light brownish yellow, slightly darker in middle part; fore tarsus yellowish light brown. Mid femora brown, with darker base and apical $\frac{1}{5}$ or so very light, brownish yellowish white; mid tibia, mid basitarsus and mid tibial spur brownish yellowish white, with slightly indicated brownish spot on upper surface of tibia near its base; apex of basitarsus and rest of tarsal segments slightly more brownish. Hind femur brown, with whitish-brownish-yellow apex; hind tibia light brown, lighter toward apical ⅓, which is whitish brownish yellow; hind tarsus whitish brownish yellow, with second to forth segments very slightly darker, and apical segment light brown.

Metasoma with dorsal and lateral surface very dark brown, almost black, and ventral surface slightly lighter, dark brown. Apical extension of hypopygium brown.

Sculpture and pubescence.—*Head:* Frontovertex, face and gena reticulate, with shallow punctures. Vertex between posterior ocelli and occiput with slightly transverse cells, face between antennal scrobe and eye orbit, and gena with very slightly vertically elongate cells. Head almost hairless, except for sparse, very short, inconspicuous hairs on vertex and face, and several longer translucent hairs on clypeus.

Mesosoma: Mesoscutum very finely, superficially reticulate-punctulate; scutellum very finely, deeply reticulate, with cells much deeper than on mesoscutum and slightly longitudinally elongate; axillae finely reticulate, with cells conspicuously deeper than on mesoscutum, but slightly shallower than on scutellum, more or less isodiametric. Pronotum, mesoscutum, axillae and scutellum with appressed translucent, very slightly brownish hairs.

Metasoma dorsally reticulate, almost hairless, laterally and ventrally with sparse translucent, slightly brownish hairs.

Male.—Similar to female in structure and color. Antenna as in Fig. 24; hypopygium as in Fig. 25; genitalia as in Fig. 26.

Color variation.—In darker specimens scape dark brown in basal ½ or so, pedicel very inconspicuously lighter in apical part; fore femur brown, with dark-brown basal part and light-brown apex, fore tibia brown, with light-brown base, gradually becoming light brown and yellowish light brown in apical ⅓; fore tarsus light brown; brownish spot near base of mid tibia more conspicuous and almost forming band; hind tibia brown with whitish-light-brown basal $\frac{1}{5}$ or so.

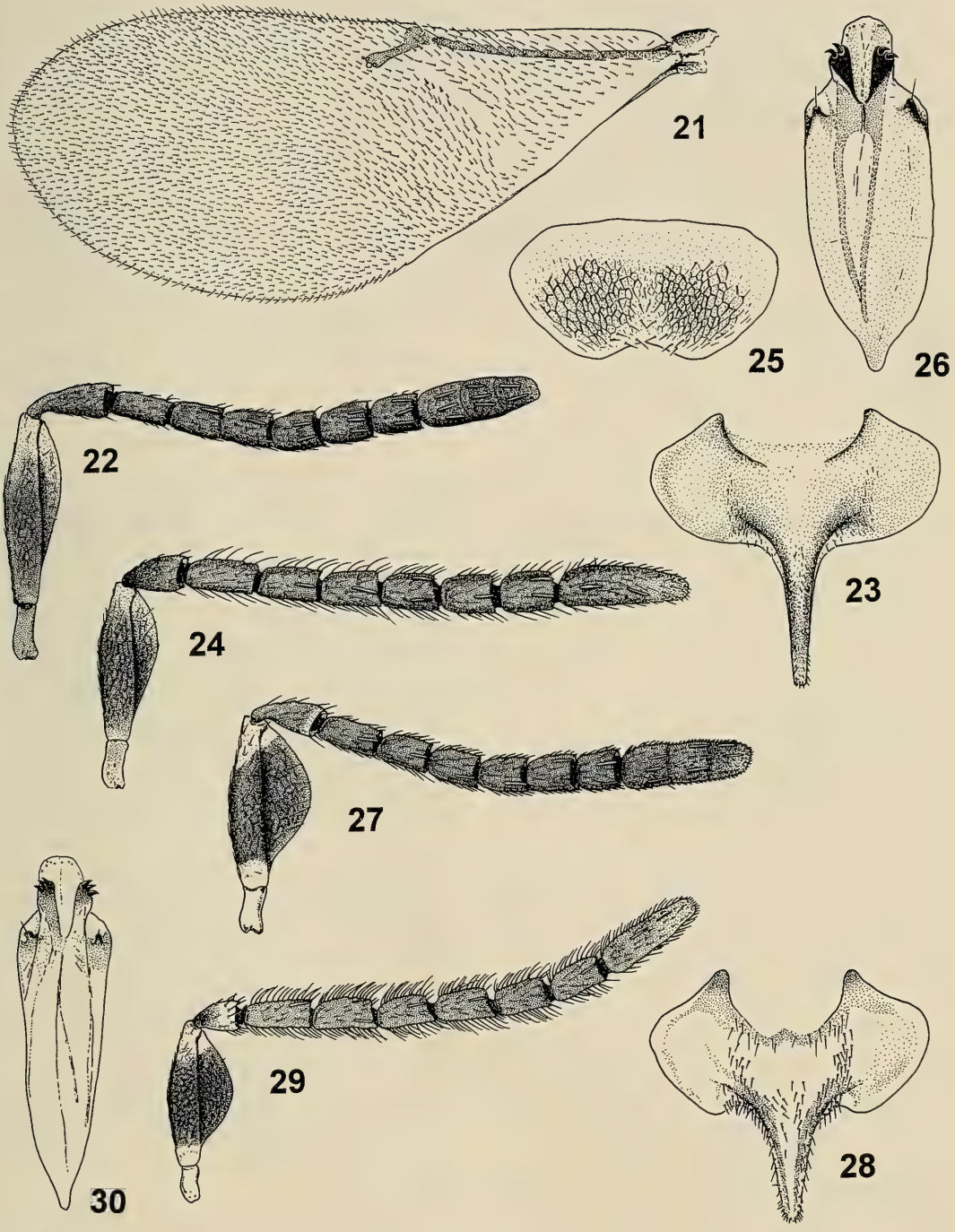
Hosts and biology.—Unknown.

Material examined.—*Holotype* female: USA, Texas, Hidalgo Co., Bentsen-Rio Grande SP, 2-6.iv.1989, J.S.Noyes (BMNH). *Paratypes:* same data, 1 female, 4 males (1 male in microslide # OSU-0006); same data, 3.vii.1982, G. A. P. Gibson, 1 male; Texas, Brewster Co., Big Bend N.P., 9–16.vii.1982, G. A. P. Gibson, 2 females, 5 males (1 female in microslide # OSU-0005); Texas, Jeff Davis Co., Davis Mts. St. Park, 4800′, 18.vii.1982, G. A. P. Gibson, 1 female; Texas, Brazos Co., College Station, Lick Creek Park, 20.ix.1992, J. S. Noyes, 1 female; Texas, Culberson Co., Guadalupe Springs, 5200′, 20–22.vii.1982, G. A. P. Gibson, 1 female (Paratypes in BMNH, CNCI, and OSUC)

Distribution.—USA (Texas).

Etymology.—The name reflects the dark, almost black color of the head and body.

Diagnosis.—Differs from all other species of *Mucrencyrtus* by the dark color of the head and the body.



Figs. 21–30. 21, *M. variabilis,* forewing. 22–26, *M. atratus.* 22, Female antenna. 23, Female hypopygium. 24, Male antenna. 25, Male hypopygium. 26, Male genitalia. 27–30, *M. arundinariae.* 27, Female antenna. 28, Female hypopygium. 29, Male antenna. 30, Male genitalia.

Mucrencyrtus dbari Sharkov, New Species

(Figs. 9, 17, 31)

Female (holotype).—Body length 1.9 mm.

Relative measurements.—*Head* width 1.85 times head length and 1.3 times head height (72:39:55). Frontovertex width at level of anterior ocellus 0.32 times width of head (23:72). Ocelli in right triangle. POL: OOL:LOL:OCL = 15:2:9:7. OOL 0.37 times diameter of posterior ocellus (1.5:4). Distance between antennal toruli 2.3 times distance between antennal torulus and eye orbit, and 2.3 times distance between torulus and mouth margin (14:6:6). Malar space 0.54 times mouth width and 0.36 times height of eye (15:28:42). Eye oval, maximum diameter 1.28 times minimum diameter (46:36). Posterior orbit of eye reaching occipital margin (dorsal view); temple not visible from above. Antenna as in Fig. 17. Scape broadened and flattened, length 2.55 times maximum width (28:11).

Mesosoma length 1.25 times width (85: 68). Mesoscutum length 0.51 times width (35:68). Scutellum length almost equal to its width (37:38). Mid tibial spur slightly shorter than mid basitarsus and 0.34 as long as midtibia (21:23:62). Forewing is shown in Fig. 31. Forewing length 2.34 times maximum width (148:63).

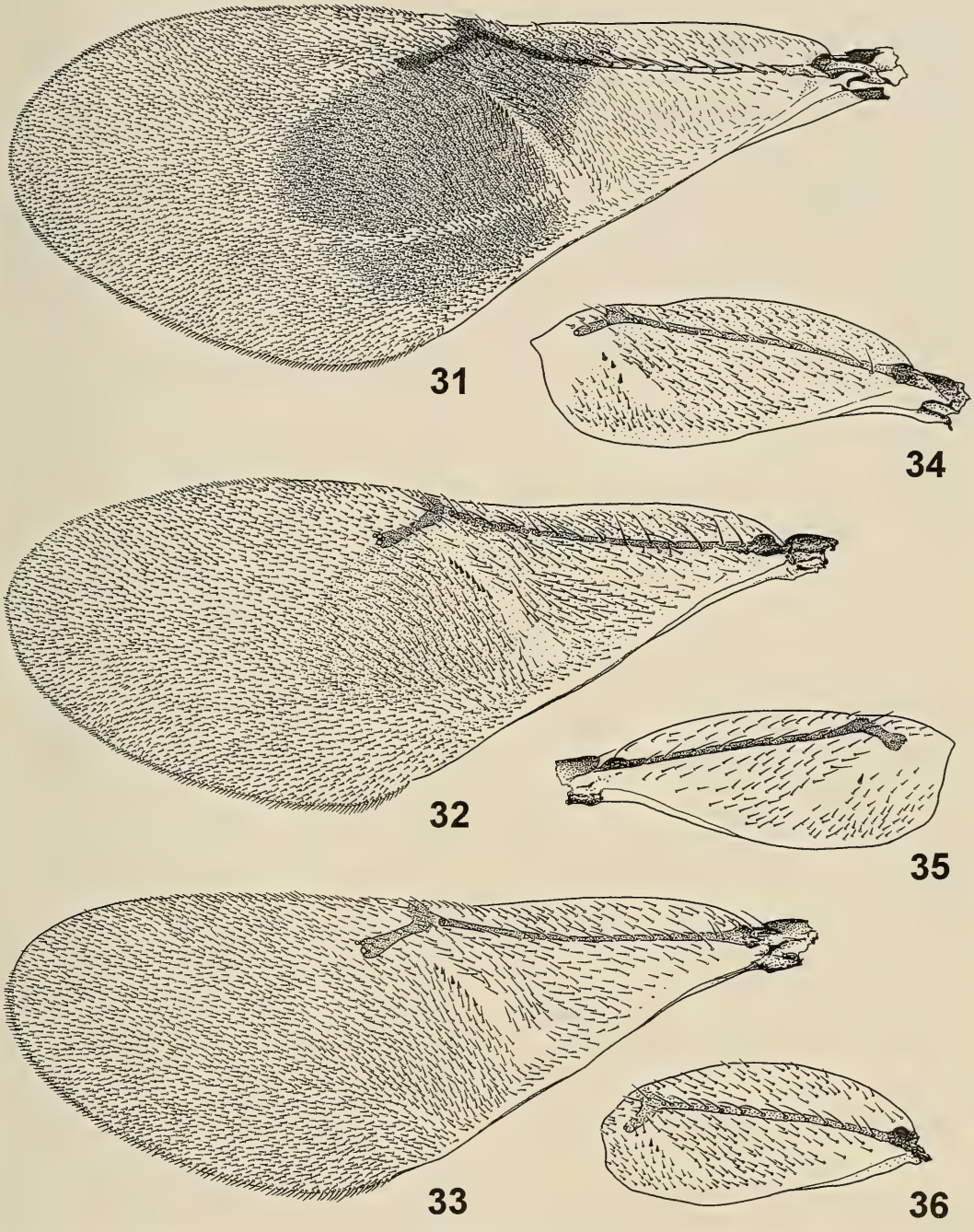
Metasoma length 1.17 times width (75: 64). Pygostyli closer to base than to apex of metasoma; distance from pygostyli to base of metasoma 0.6 times corresponding distance to apex of metasoma (28:47).

Color.—*Head:* Frontovertex orange; face yellowish white, except for small brown spot at upper end of carinate part of interantennal prominence, and with slightly larger transverse brown spot at its lower end, and brown area between antennal scrobe and eye orbit; gena dark brown, almost black, except for yellowish white area adjacent to eye orbit that gradually becomes brown in upper part (Fig. 9); occiput dark brown, except for narrow yellowish area behind eye. Antenna with radicle dark brown; scape dark brown, almost black, except for whitish base and apical ⅕; pedicel brown with lighter apical part; funicle and clava brown. Mandibles brown.

Mesosoma: Pronotum with collum dark brown, almost black; collar white anteriorly and dark brown posteriorly; sides dark brown, except for white anterolateral corner, adjacent to fore coxa. Mesoscutum dark brown, very slightly lighter, dark orange brown laterally and anteriorly, except in middle. Axillae dark brown, very slightly lighter than mesoscutum. Scutellum dark brown, with brownish orange sides and apex, and with small dark brown orange area anteriorly in middle, near connection of axillae. Mesopleuron brown, with white posterior ⅕. Forewing with very light, almost whitish, hyaline basal ⅓, large dark (brownish) infuscated area in middle ⅓, and hyaline apical ⅓; setae and part of submarginal vein corresponding to basal ⅓ of forewing lighter in color than setae in middle and apical ⅓ of wing (Fig. 31). Fore leg with coxa white, femur brownish white, with white base and apex; tibia brownish white, and tarsus whitish light brown. Middle leg with coxa brown, femur white, tibia brownish white with lighter lower surface, mid tibial spur and tarsus brownish white with apical tarsomeres gradually becoming slightly darker, whitish brown. Hind leg with coxa brown, femur brown except for small white area near its apex on upper surface, tibia brown with whitish base, and gradually becoming brownish white in apical ⅓; tarsus whitish light brown. Metanotum and propodeum dark brown, almost black, lighter in middle part. Anterolateral corner of propodeum (adjacent to hindwing base) white.

Metasoma: Dark brown, almost black dorsally, and slightly lighter, dark-brown to brown ventrally. Exserted part of ovipositor sheaths brownish white.

Sculpture and pubescence.—*Head:* Frontovertex reticulate, with more or less isodiametric cells, and with very shallow,



Figs. 31–36. Forewings. 31, *Mucrencyrtus dbari,* female. 32, *M. arundinariae,* female. 33, *M. ecuadorensis,* female. 34, 35, *Mucrencyrtus* sp. aff. *ferrierei:* 34, Female; 35, Male. 36, *M. ferrierei,* female.

inconspicuous punctures, the punctures slightly better visible around anterior ocellus. Gena laterally with elongate-reticulate sculpture and scattered shallow punctures.

Mesosoma: Pronotum finely reticulate. Mesoscutum very finely reticulate, with rather dense setiferous punctures. Axillae reticulate. Scutellum reticulate with cells

larger and deeper than on mesoscutum, elongate in central part, and more or less isodiametric anteriorly, laterally and posteriorly. Mesopleuron finely reticulate, with cells more or less isodiametric, shallower than on other parts of mesosoma. Propodeum reticulate, with weakly expressed carinae in middle part, the carinae slightly diverging posteriorly. Dorsal surface of mesosoma with brownish translucent setae, the setae appearing slightly darker on whitish anterior part of collar of pronotum. Setae on apex of scutellum and on anterolateral corner of propodeum whitish, translucent.

Metasoma with first tergite transversely reticulate anteriorly, and more or less isodiametrically reticulate posteriorly; other tergites reticulate, with cells becoming slightly larger and shallower toward the apex of metasoma.

Male unknown.

Hosts and biology.—Unknown.

Material examined.—*Holotype* female: COSTA RICA, Guanacaste Pv, Sta. Rosa NP, Hacienda, Janzen & Gauld, 10–31.i.1987 (antenna and forewing in microslide # OSU-0004) (BMNH)

Distribution.—Costa Rica.

Etymology.—Named after my friend and colleague, Abkhazian hymenopterist Roman S. Dbar.

Diagnosis.—Close to *M. aclerdae,* from which it differs by characters given in the key: more strongly broadened and flattened scape, greater distance between antennal toruli, and different color of the head and mesosoma.

Mucrencyrtus ecuadorensis Sharkov, New Species

Figs. 18, 33

Female (holotype).—Body length 1.7 mm.

Relative measurements.—*Head* width 1.77 times head length and 1.26 times head height (62:35:49). Frontovertex width at level of anterior ocellus 0.37 times width of head (23:62). Ocelli in very slightly acute triangle, with angle at anterior ocellus of 85°. POL:OOL:LOL:OCL = 15:2:10.5:5. OOL 0.74 times diameter of posterior ocellus (2:2.7). Distance between antennal toruli 1.37 times distance between antennal torulus and eye orbit and 1.47 times distance between torulus and mouth margin (11:8:7.5). Malar space 0.68 times mouth width and 0.38 times height of eye (13:19:34). Eye oval, maximum diameter 1.2 times minimum diameter (36:30). Posterior orbit of eye almost reaching occipital margin (dorsal view). Antenna as in Fig. 18. Scape subcylindrical, with very weakly developed flange, its length 3.43 times maximum width (24:37).

Mesosoma length 1.3 times width (68:52). Mesoscutum width 1.73 times length (52:30). Scutellum length slightly less than width (28:31). Mid tibial spur 0.88 as long as mid basitarsus and 0.27 as long as mid tibia (15:17:55). Forewing is shown in Fig. 33. Forewing length 2.51 times maximum width (118:47).

Metasoma length 1.2 times width (65:55). Pygostyli closer to base than to apex of metasoma. Distance from pygostyli to base of metasoma 0.54 times corresponding distance to apex of metasoma (23:42).

Color.—Head and body largely yellow. Antennae yellow. Mandibles with brown apical ½ Collum of pronotum slightly brownish in area of its contact with occiput. All legs yellow. Mesopleuron yellowish brown, lighter in anterior part, and darker (brown) in posterior part. Forewing hyaline. Metasoma brownish yellow, with darker dorsal side.

Sculpture and pubescence.—*Head* reticulate, with shallow punctures on frontovertex, which appears almost hairless, with very short, minute, translucent hairs on vertex, face, and genae, and longer setae on clypeus.

Mesosoma: Mesoscutum and scutellum minutely, superficially reticulate, with cells on scutellum very slightly elongate, but not deeper than on mesoscutum. Collar of pronotum, mesoscutum, axillae and scutellum with appressed brownish hairs.

Metasoma dorsally shallowly reticulate and almost hairless, laterally and ventrally with translucent hairs, the hairs denser on ventral surface.

Male unknown.

Hosts and biology.—Unknown.

Material examined.—*Holotype* female: ECUADOR: Pichincha, 47 km S Santo Domingo, Rio Palenque Station, 28.v.1975, S.&J. Peck (antenna and forewing on microslide #OSU-0007) (CNCI).

Distribution.—Ecuador.

Etymology.—Name refers to the country of origin.

Diagnosis.—Similar to *M. ferrierei* (Burks), from which it differs by the color of the mesopleuron, which is darker than the rest of mesosoma, and by the more slender scape.

Mucrencyrtus ferrierei (Burks)
(Figs. 19, 20, 36)

Aenasioidea ferrierei Burks, 1964: 18. Holotype female, USA (USNM) (not examined).

Mucrencyrtus ferrierei: Noyes and Woolley, 1994: 1332.

Distribution.—USA: Maryland, Virginia, Georgia, Florida, Texas.

Hosts and biology.—Reared from *Aclerda andropogonis* McConnel on *Andropogon virginicus* (Burks, 1964).

Comments.—The species was described from 27 brachypterous females and 4 macropterous males reared from same host (Burks, 1964). I have examined 7 paratype females and 2 paratype males from the USNM, and additional 80+ specimens from Georgia, Florida and Texas that are conspecific with the specimens of the type series. A further 61 specimens from Virginia, Florida and Texas are very similar to *M. ferrierei,* but differ by darker (dark brown to almost black) funicle and clava, slightly more elongated funicular segments, and a dark spot or band in the middle part of the scape in females and males (Figs. 10, 12). The sculpture of the scutellum (especially in its posterior ½) in these specimens consists of slightly larger cells than those on the mesoscutum, and the pubescence of the scutellum is relatively sparser than in specimens of the type series of *M. ferrierei.* Forewing rudiments in brachypterous specimens are relatively more elongated, with rounded or pointed, but never truncate apex (Figs. 34, 35). The apical extention of hypopygium is relatively longer than in specimens of the type series of *M. ferrierei* (Fig. 11). However, despite all these differences, I am not confident enough to describe a new species for these specimens until more material is obtained and the variability of *M. ferrierei* is studied in greater detail. Therefore, at the present time I have identified these specimens as *Mucrencyrtus* sp. aff. *ferrierei,* and in the key they will key to *M. ferrierei.*

Variation.—In addition to the features listed above, some characters may vary as follows. Forewings in both sexes may be fully developed to very short and rudimentary, with all transitional forms. Dark areas on the occiput, pronotum and mesoscutum in males may vary from well expressed to completely absent. The scape may have a small dark spot in the middle, and the funicle and clava may be yellowish brown, slightly darker than scape. Dorsal surface of propodeum, except median part, may be darkened, yellowish brown or brown.

Mucrencyrtus insulanus Noyes

Mucrencyrtus insulanus, Noyes, 1980: 214. Holotype female, Trinidad (BMNH) (not examined).

Distribution.—Trinidad, St. Vincent.

Hosts and biology.—Reared from *Aclerda* sp. on sugarcane (Noyes, 1980).

Material examined.—*Paratypes:* TRINIDAD: Orange Grove, i.1973, ex *Aclerda* sp. on sugarcane (F. D. Bennett), 1 female (BMNH); Curepe, Santa Margarita Circular Road, 15–18.i.1974 (F. D. Bennett), 1 female (CNCI); ST. VINCENT: St. George,

Argyle, 8.vii.1976, coastland (J. S. Noyes), 1 male (BMNH).

Comments.—This species is very similar to *M. ferrierei,* differing from it by the deeper and finer sculpture of the scutellum compared to that of the mesoscutum, and more slender scape.

Mucrencyrtus variabilis Sharkov, New Species

Figs. 6–8, 13–16, 21

Female (holotype).—Body length 1.24 mm.

Relative measurements.—*Head* width 1.77 times head length and 1.23 times head height (48:27:39). Frontovertex width at level of anterior ocellus 0.47 times width of head (22.5:48). Ocelli in an obtuse triangle, with angle at anterior ocellus of 113°. POL: OOL:LOL:OCL = 15:1.5:9.5:4.5. OOL 0.75 times diameter of posterior ocellus (1.5:2). Distance between antennal toruli 1.25 times distance between antennal torulus and eye orbit and twice distance between torulus and mouth margin (10:8:5). Malar space 0.77 times mouth width and 0.58 times height of eye (14:18:24). Eye oval, maximum diameter 1.22 times minimum diameter (27:22). Posterior orbit of eye reaching occipital margin (dorsal view). Antenna as in Fig. 13. Scape very slightly broadened and flattened, length 3.4 times maximum width (17:5).

Mesosoma length 1.15 times width (51: 44). Mesoscutum width 2.44 times length (44:18). Scutellum length slightly less than width (24:26). Mid tibial spur 0.88 as long mid basitarsus and 0.28 as long as mid tibia (10.5:12:37). Forewing as in Fig. 21. Forewing length 2.31 times maximum width (95:41).

Metasoma length approximately equal to width (52:51). Distance from pygostyli to base of metasoma 0.48 times corresponding distance to apex of metasoma (17:35). Hypopygium as in Fig. 15.

Color.—*Head* yellow, except for dark-brown oblique spot on gena (Figs. 7, 8) and large dark-brown spot on occiput occupying area of contact of occiput with collum of pronotum. Antennae entirely yellow. Mandibles with yellow basal and brown apical parts.

Mesosoma: Pronotum with collum dark brown in area of its contact with occiput, and yellow on upper edge and sides; collar yellow. Mesoscutum yellow, slightly darker, brownish yellow, anteriorly, and slightly lighter, whitish yellow, posteriorly. Axillae yellow with anterior margin dark-brown, and inner corner, and lateral and posterior margins brown. Metanotum and propodeum dark brown, except anterolateral corners of propodeum (adjacent to hindwing base and anterior to spiracle) whitish yellow. Mesopleuron whitish yellow. Tegula light brown with whitish-yellow base. Forewing hyaline, very slightly, almost inconspicuously suffused yellow in basal $\frac{1}{3}$ or so. All legs completely yellow.

Metasoma dorsally yellowish brown, darker (almost dark brown) in basal part, gradually becoming lighter in apical part, so IX syntergite is brownish yellow; laterally brownish yellow and yellow ventrally.

Sculpture and pubescence.—*Head:* Frontovertex, face and genae shallowly reticulate, with numerous small, shallow punctures and very minute, translucent, inconspicuous hairs on genae and face between antennal scrobe and eye orbit.

Mesosoma: Pronotum, mesoscutum, axillae and scutellum shallowly reticulate, with numerous small setiferous punctures and appressed brownish translucent hairs. Metanotum and propodeum dorsally transversally reticulate, except for median part; sides of propodeum with translucent hairs.

Metasoma dorsally shallowly reticulate, anteriorly with transverse cells; almost hairless dorsally, and with brownish translucent hairs on lateral part of tergites and on sternites.

Male.—Similar to female in structure and coloration. Antenna as in Fig. 16.

Variation.—This species exhibits the greatest variation in structure and color among the members of the genus *Mucren-*

cyrtus. The two most variable features are the size of the eyes and the degree of expression of the dark oblique spot on the gena. In some specimens (females and males) from Texas the eyes are very small (Figs. 6, 7), the eye height is about ½ the height of the head (16:33), and the eye length is only about 0.7 the length of the head. The posterior orbit of the eye in this case does not reach the occiput, so that the temple is well visible from above, and the length of the temple constitutes more than ⅕ the head length (5:22). Other proportions of the parts of the head also vary respectively. The width of the frontovertex in small-eyed specimens is more than ½ the head width (22:39) and the OOL is up to twice the ocellus diameter (4:2). The dark-brown oblique spot on the gena varies in size and darkness (Figs. 7, 8), and may be completely absent. There is no correlation between the two features, or between either feature and geographical origin of the specimens. Specimens with large, small, and intermediate size eyes were collected from same locality in Texas, although only large-eyed specimens are known so far from Arizona, California, and Mexico. The hypopygium of a small-eyed specimen is shown in Fig. 14. Males from Mexico are slightly darker colored than the specimens from the USA. They have an orange frontovertex, a dark-brown spot in the middle part of the scape, a brown funicle, and brown to dark-brown anterior ½ or so of the mesoscutum and the base of the scutellum. In one male from Texas the anterior margin of the mesoscutum is dark brown, but the dark area does not extend as far posteriorly as in Mexican specimens. In some specimens the scape is slightly more broadened, its length being 3.1 times its maximum width.

Hosts and biology.—Unknown.

Material examined.—*Holotype* female: USA: Arizona, Portal, Cave Creek Canyon, viii.1977, L. Masner (CNCI). *Paratypes:* USA: Arizona, Cochise Co., 12 km S. Sierra Vista, Ramsey Canyon, 1700 m, 29.vi.1987, 9.vii.1987, B. V. Brown, 4 females, 2 males (1 female in microslide # OSU-0009); Arizona, Cochise Co., Chiricahua Mts., S.W.R.S., 5400′, 4–7.v.1980, V. Roth, 1 female; California, San Louis Obispo Co., 8 mi ESE Simmler, San Diego Creek, 22–30.vi.1987, D. B. Wahl, 1 female; Texas, Presidio Co. Big Bend Ranch SNA, 29°30′45″N 103°51′56″W, el. 4400′, 21.vi.1990, Woolley & Zolnerowich, 2 females; same data, 19 & 21.vi.1990, Zolnerowich, 4 females, 1 male (1 female in microslide # OSU-0008); same data, 29°30′20″N 103°52′15″W, 21 & 23.vi.1990, Zolnerowich, 1 female, 1 male; same data, 1.8 mi W Los Alamos Rn., 19.x.1990, el. 4360′, Zolnerowich, 1 male; Texas, Brewster Co., Big Bend National Park, No. Rosillos Mts. Buttrill Spring, 29°31′53″N 103°15′22′W, el. 5370′, 15.vi.1991, G. Zolnerowich, 1 male; same data, 15–18.vi.1991, Wharton & Whitefield, cottonwood, malaise trap, 1 female; same data, 10–9.vii.1991, R. Vogtsberger, 1 male; Texas, Brewster Co., Big Bend N.P., 5200′, 9.vii.1982, G. A. P. Gibson, 1 female; Texas, Burnet Co., Inks Lake St. Park, 2.v.1987, J. B. Woolley, 1 female; Texas, Val Verde Co., Seminole Cyn. St. Park, 20.vii.1986, Woolley & Zolnerowich, 1 male; Texas, Comal Co., Guadalupe River St. Park, 18.viii.1988, G. Zolnerowich, 1 male; Texas, Jeff Davis Co., Davis Mts. St. Park, 5000′, 17–18.vii.1982, G. A. P. Gibson, 5 males (1 male in microslide # OSU-0010); Texas, Hidalgo Co., Bentsen-Rio Grande S.P., 2–6.iv.1989, J. S. Noyes, 1 female; Texas, (Starr Co.), Falcon Lake S.P., 8.iv.1989, J. S. Noyes, 1 female; MEXICO: Veracruz, 3 mi NE Huatusco, 22.vii.1985, J. Woolley & G. Zolnerowich, 1 female; same data, 23.vii.1984, J. B. Woolley, 1 male; Puebla, 5 mi SE Izucar de Matamoros, 20.vii.1984, J. B. Woolley, 2 males (Paratypes in BMNH, CNCI, OSUC, and TAMU).

Distribution.—USA (Arizona, California, Texas), Mexico.

Etymology.—The name reflects the high degree of intraspecific variation.

Diagnosis.—From *M. aclerdae,* which

also possesses a dark oblique spot on the gena, this species differs by the absence of a dark infuscation from the forewing. Specimens that lack the dark spot from the gena resemble *M. ferrierei,* from which they differ in the obtuse anterior angle of the ocellar triangle, the darker metanotum and dorsal part of propodeum, and, usually, the more slender scape.

Mucrencyrtus sp.

This undetermined species is known only from three males collected in a Malaise trap in Uruguay. It is not included in the key.

Acknowledgments

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A NEW SPECIES OF *ENTEDONONECREMNUS* (HYMENOPTERA: CHALCIDOIDEA: EULOPHIDAE) PARASITIC ON THE GIANT WHITEFLY, *ALEURODICUS DUGESII* COCKERELL (HOMOPTERA: ALEYRODIDAE)

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Abstract.—***Entedononecremnus krauteri* new species** is described and illustrated. This species is a primary parasite of an invading whitefly, *Aleurodicus dugesii* Cockerell, and is the first parasite reared from that host in the United States. This parasite has been transferred to several parts of Texas and California as part of biological control efforts to regulate the whitefly.

Key Words: *Entedononecremnus krauteri, Aleurodicus dugesii,* Eulophidae, Chalcidoidea, Aleyrodidae, biological control.

Aleurodicus dugesii Cockerell (1896), commonly called the giant whitefly, was described from *Hibiscus* collected in Guanajuato, Mexico. This whitefly was first reported in the United States from Balboa Park, San Diego, California, in October 1992 (R. Gill, pers. comm.). *Aleurodicus dugesii* has since been discovered in Texas and Louisiana. Mound and Halsey (1978) list one genus from each of the plant families Annonaceae, Begoniaceae, Chrysobalanaceae, Malvaceae, and Moraceae as host plants, but the whitefly has been found on a number of different genera and families in the U.S.

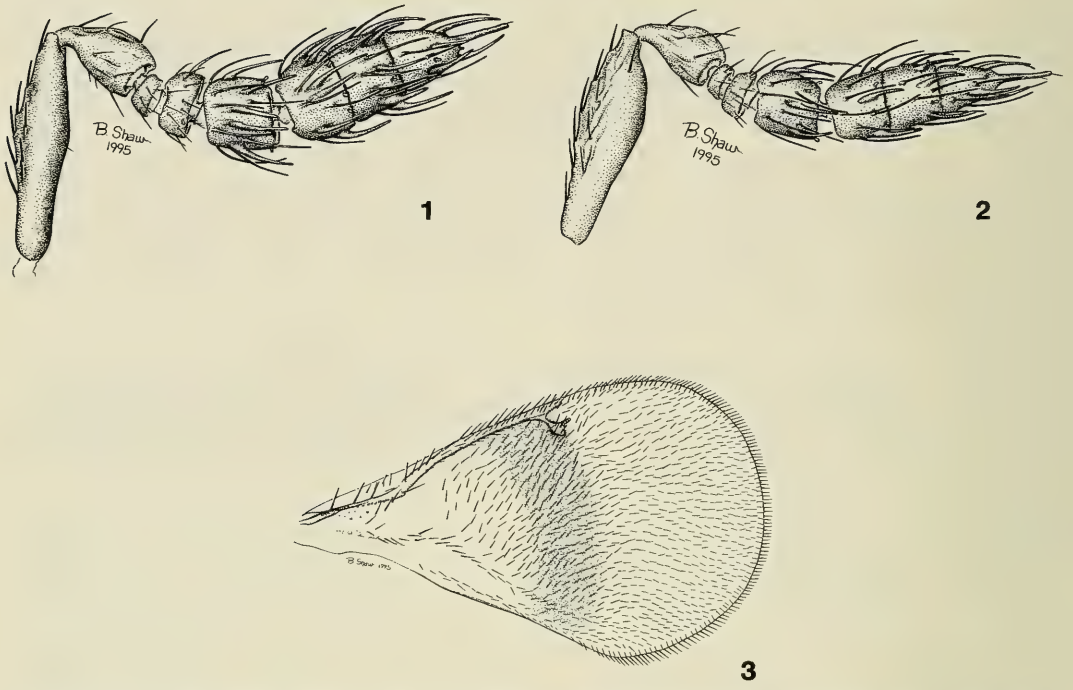
Parasites of this whitefly have not been previously reported. The serendipitous discovery of a parasite attacking giant whitefly in Texas represents the first recovery of a parasite of *A. dugesii* in the United States. The parasite is an undescribed species of *Entedononecremnus* Girault (Hymenoptera: Chalcidoidea: Eulophidae: Entedoninae) and is named here to facilitate its use in biological control efforts.

Entedononecremnus contains a single described species, *E. unica* Girault (1915), but additional undescribed species are known (LaSalle and Schauff 1994). Members of the genus belong in Euderomphalini, which contains all known eulophid whitefly parasites. LaSalle and Schauff (1994) provide an excellent systematic review of Euderomphalini, including a key to genera by which *Entedononecremnus* can be distinguished and a diagnosis of the genus.

Basic morphological terminology used here follows that of Schauff (1991). Following are abbreviations for institutions and collections: BMNH, The Natural History Museum, London, United Kingdom; CDFA, California Department of Food and Agriculture, Sacramento; CNC, Canadian National Collection, Ottawa, Canada; IIE, International Institute of Entomology, London, United Kingdom; SDCDA, San Diego County Department of Agriculture, San Diego; TAMU, Texas A&M University, College Station; UCR, University of California, Riverside; USNM, National Museum of Natural History, Washington, D.C.

Entedononecremnus krauteri Zolnerowich and Rose, New Species

Diagnosis. Specimens of *Entedononecremnus krauteri* can be separated from the



Figs. 1–3. *Entedononecremnus krauteri.* 1, Antenna, female, outer aspect. 2, Antenna, male, outer aspect. 3, Forewing, female.

only other described species in this genus, *E. unicus,* by the following characters: head and mesosoma with reticulate sculpture consisting of relatively wide cells (Figs. 5, 6), mesosoma dorsally convex in lateral view (Fig. 4), mesoscutum and scutellum each with several setae arranged in pairs (Fig. 6), and forewing with an infuscate band and short stigmal vein (Fig. 3).

Entedononecremnus unicus has reticulate sculpture with much finer cells (as in Fig. 38, LaSalle and Schauff 1994), the mesosoma is much less convex in lateral view, the mesoscutum and scutellum have numerous setae not arranged in pairs (as in Fig. 31, LaSalle and Schauff 1994), the forewing is hyaline, and the stigmal vein is elongate and shaped differently (as in Fig. 50, LaSalle and Schauff 1994).

Although *E. krauteri* is very distinct from *E. unicus,* it falls well within the range of variation noted by LaSalle and Schauff (1994) for the genus. They noted undescribed species of *Entedononecremnus* may vary in the number and arrangement of setae on the mesoscutum and scutellum, and in the length and shape of the stigmal vein. Undescribed species examined also have varying degrees of infuscation on the forewings. Although LaSalle and Schauff (1994) state that males of Euderomphalini lack pores within the ventral groove of the scape, such pores are evident in *E. krauteri* (Fig. 9).

Female. Length 0.98–1.17 mm. Head and body black with white or pale blue purple highlights; first gastral tergite metallic blue green, remaining tergites black with purple highlights. Scape and pedicel testaceous, funicular segments and club beige, apical spine on club black. Coxae black; trochanters dark brown; fore- and midfemora black, or black with the extreme distal portion testaceous, hind femur black with distal 1/7 testaceous; tibiae black in proximal 1/4–1/2, remainder testaceous to brown; foretarsi 1-3 tan to brown, foretarsus 4 brown to black, mid- and hind tarsi

1-3 white to testaceous, mid- and hind tarsus 4 brown to black. Forewing hyaline except for short basal infuscate streak below submarginal vein and infuscate band extending from distal half of marginal vein and stigmal vein to posterior margin of wing (Fig. 3); venation dark brown, parastigma varying from hyaline to brown.

Head with strong reticulate sculpture and without frontal or malar sulci (Fig. 5). Eye glabrous. POL:OOL 6:3. Mandible with 2 teeth, dorsal tooth longer than the ventral.

Scape slightly more than 4× longer than broad and widest in the middle, outer surface with very few setae, inner surface with numerous setae; pedicel 0.4× length of scape; flagellum composed of anellus, 2 funicular segments, and 3-segmented club with long apical spine; first funicular segment 1.7× broader than long and with a single multiporous plate sensillum on the inner side, second funicular segment subquadrate and nearly 2× length of first funicular segment, club slightly more than 2× length of funicular segments (Fig. 1).

Mesosoma dorsally convex in lateral view and slightly shorter than metasoma (Fig. 4), with strong reticulate sculpture dorsally (Fig. 6). Mesoscutum with 5 pairs of setae, notauli absent but mesoscutum with depressed areas on either side. Scutoscutellar sulcus deep. Axillae extending forward about 1/3 length of the mesoscutum. Scutellum slightly wider than long and with 4-6 pairs of setae. Midtibial spur setose (Fig. 8).

Forewing venation with proportions as follows: submarginal vein, 59; marginal vein, 37; stigmal vein, 10; postmarginal vein, 7. Submarginal vein with 3 setae proximal to parastigma (Fig. 3).

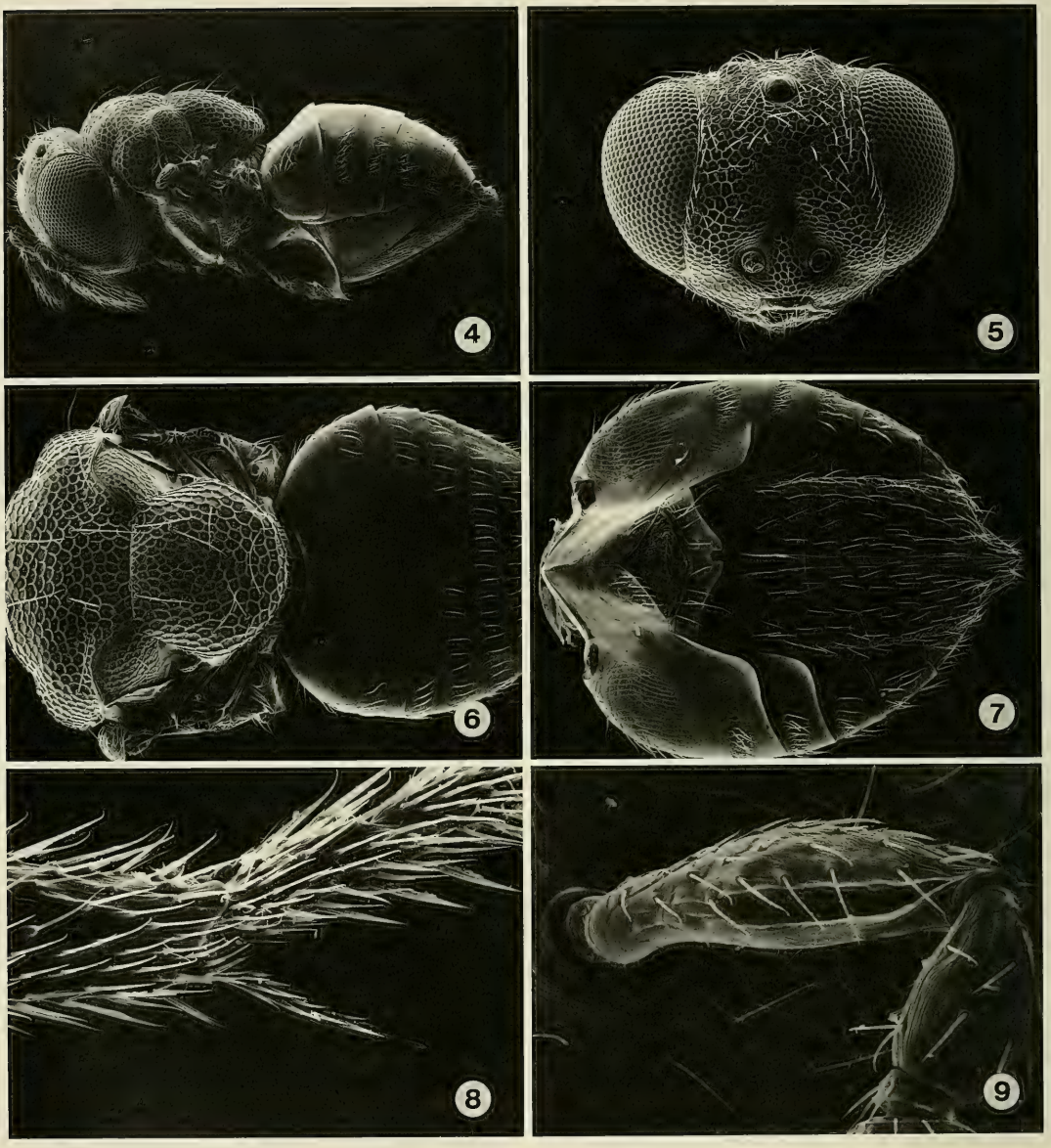
Gaster slightly longer than mesosoma, first gastral tergite the longest, polished dorsally (Fig. 6) and with lateroventral longitudinal striations (Fig. 7). Remaining tergites shorter and with fine transverse sculpture dorsally and short longitudinal striations ventrally. Sternites reduced in length and with a membranous area anterior to hypopygium (Fig. 7). Ovipositor 0.8× length of metasoma and slightly exserted.

Male. Length 0.99–1.14 mm. Similar to female but usually slightly shorter and less robust. Scape 3.3–4.0× longer than broad and with a ventral cleft containing pore openings (Fig. 9), second funicular segment slightly longer than broad and about 3× length of first funicular segment, club 2.5× length of funicular segments (Fig. 2).

Notes. Entedononecremnus krauteri is a primary parasite of *Aleurodicus dugesii.* No other hosts are known. Initial field collections of adults associated with *A. dugesii* on *Hibiscus syriacus* L. made on October 10, 1995, were heavily male-biased. Leaves bearing parasitized whitefly held in the lab produced parasites of both sexes, with a female:male sex ratio of 5.6:1. Adults emerge from fourth-instar whitefly larvae. A female videotaped during emergence took over 1.5 hours to chew the exit hole and emerge from the host. Adults emerge with the pupal exuviae still enveloping their antennal clubs. The exuviae are removed with the forelegs shortly after emergence.

The giant whitefly attacks 43 plant genera in 35 families in San Diego County, California (D. Kellum, pers. comm.). Approximately 3400 parasites reared at TAMU and shipped to San Diego County were colonized at 11 different sites in that county during October 1995. Host plants on these sites included *Aralia, Citrus, Cucurbita* (Chayote squash), *Geranium, Hemerocallis* (daylily), *Hibiscus, Persea* (avocado), and *Xylosma.* Adult parasites were still present in the field 10 days after colonization. *Entedononecremnus krauteri* has successfully overwintered and reproduced in San Diego County, and will be evaluated for efficacy in biological control of the giant whitefly (C. Pickett, pers. comm.).

Additional parasites were released at three sites in Texas that included plants grown indoors. These sites were the San Antonio Botanical Garden (800 parasites), Houston Museum of Natural Sciences



Figs. 4–9. *Entedononecremnus krauteri.* 4, Habitus, female. 5, Head, female. 6, Mesonotum and metasoma, female. 7, Metasoma, female, ventral view. 8, Midtibial spur, female. 9, Scape, male, ventral view.

Cockerell Butterfly Center (400 parasites), and the Fort Worth Botanical Garden (60 parasites). *Entedononecremnus krauteri* was later found attacking giant whitefly on *Hibiscus* growing outdoors at the San Antonio Botanical Garden. It remains unknown if *E. krauteri* is native to North America or if this is a case of fortuitous ecesis (DeBach 1971).

Etymology. Named in honor of P. C. Krauter, who found the parasite and its host in his hometown of Comfort, Texas.

Types. Holotype female mounted on a card, "Texas: Kendall Co., Comfort, Altgelt Ave., 10.X.1995, G. Zolnerowich" "*Aleurodicus dugesii* on *Hibiscus syriacus*". Holotype deposited in USNM. Twenty-three female and 18 male para-

types with same data as holotype deposited in BMNH, CDFA, CNC, TAMU, UCR, and USNM.

Acknowledgments

We express our gratitude to: P. C. Krauter for finding the parasite; G. A. P. Gibson (Biological Resources Division, Centre for Land and Biological Resources Research), M. E. Schauff (Systematic Entomology Laboratory, USDA), and J. B. Woolley (TAMU) for their review of the paper and loan of type specimens of *E. unicus*; J. LaSalle (IIE) for his discussions and loan of other undescribed species of *Entedononecremnus*; R. Gill (CDFA) for information on hosts; C. Pickett (CDFA) and D. Kellum (SDCDA) for information on parasite releases and host plants; B. Shaw for line drawings; D. Knott (USDA, APHIS, PPQ) for expediting interstate shipment permits; and E. Morrison and R. S. Stauffer for rearing, shipping, and colonizing parasites.

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98(2), 1996, pp. 374–375

NOTE

Use of an Introduced Host, Scotch Pine, by a Native Planthopper, *Thionia bullata* (Homoptera: Fulgoroidea: Issidae)

Thionia Stål is a New World genus of issid planthoppers that contains 72 species. Of the eight species occurring in North America north of Mexico, biological information other than an occasional reference to host plants is available only for three species. *Thionia elliptica* (Germar) is a univoltine oak feeder that develops on branches of scrub oak (*Quercus ilicifolia* Wang.) in pitch pine-scrub oak barrens in Pennsylvania; it has also been collected from blackjack oak (*Q. marilandica* Muenchh.) (Wheeler and Wilson 1987. Journal of the New York Entomological Society 95:440–451). In the southern states, *T. bullata* (Say) develops on pines such as *Pinus echinata* Mill., *P. taeda* L., and *P. virginiana* Mill. The polyphagous *T. simplex* (Germar) has been observed on 12 species of herbaceous and woody plants in the eastern United States (Wheeler and Wilson 1988. Journal of the New York Entomological Society 96:266–273). All five nymphal instars have been described for *T. elliptica* and *T. simplex,* and third through fifth instars for *T. bullata* (Wheeler and Wilson 1987, 1988).

Discovery of *T. bullata* on pines represented one of the relatively few records of an issid from a coniferous host (Wilson et al. 1994. *In* Denno and Perfect, eds., Chapman and Hall, New York, pp. 7–113). Here I report use of the introduced Scotch pine (*P. sylvestris* L.) as an additional host and give notes on its seasonal history.

Observations of *T. bullata* were made on a mature Scotch pine on the Furman University campus, Greenville, South Carolina. Nymphs were abundant on 15 July 1988; 10 third, 23 fourth, and 4 fifth instars were collected. At about this same time in 1995 (14 July) only fifth instars were present. Adults and a few fifth instars were present on 11 Aug. 1989. Two first instars were beaten from branches of the same tree on 11 May 1995, suggesting that overwintered eggs had just begun to hatch. This issid, like *T. elliptica* (Wheeler and Wilson 1987), appears to be univoltine, with nymphal development requiring about 10 weeks.

Scotch pine has recruited a diverse insect fauna in the New World, one that includes European species now naturalized in North America (Drooz, ed. 1985. U.S. Department of Agriculture, Forest Service. Miscellaneous Publication 1426, Washington, D.C.; Wheeler and Henry 1992. Thomas Say Foundation Monograph 25, Entomological Society of America, Lanham, Md.), as well as native herbivores that have adapted to this introduced tree species (e.g. Knight 1941. Bulletin of the Illinois Natural History Survey 22: 1–234).

Thionia bullata is an apparent pine specialist that has colonized Scotch pine at Greenville, S.C., its population persisting since at least 1988. This issid is another example of an indigenous herbivore known to have expanded its host range to include an adventive species (see Strong et al. 1984. Harvard University Press, Cambridge, Mass.). Such a host switch can involve "geographic proximity, physical and temporal suitability, and taxonomic and chemical similarity to native hosts" (Berenbaum and Zangerl 1991. Oikos 62: 153–159). Host switching may often be mediated by plant secondary chemistry (e.g. Miller and Wenzel. 1995. Annual Review of Entomology 40: 389–415). In some cases the primary barriers to host range expansion seem to be behavioral rather than physiological (e.g. Karowe 1990. Evolution 44: 1637–1647).

Voucher specimens have been depos-

ited in the collection of S. W. Wilson, Central Missouri State University, Warrensburg.

I thank S. W. Wilson for confirming the identification of *T. bullata,* determining nymphs to instar, and providing helpful comments on the manuscript; and C. A. Stoops, Department of Entomology, Clemson University, Clemson, S.C., for helping collect issids in 1995.

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NOTE

Validation of *Neosarcophaga* Shewell *nomen nudum* (Diptera: Sarcophagidae)

When the genus name *Neosarcophaga* was initially proposed by me for nine included species in the key to genera for the family Sarcophagidae in the *Manual of Nearctic Diptera,* Volume 2 (Shewell 1987, Agriculture Canada Monograph No. 28: 1168), it was a *nomen nudum,* being without type species citation. Dr. Thomas Pape of the Swedish Museum of Natural History, Stockholm, has recently written to me in connection with his pending publication of a catalog of world Sarcophagidae, stating that he would like to have *Neosarcophaga* validated by publication of a type species designation. I therefore now designate *Sarcophaga occidentalis* Aldrich (1916, Entomological Society of America, Thomas Say Foundation 1: 198) as type species of *Neosarcophaga* Shewell. It and the following species, namely *Sarcophaga canadensis* Hall (1929, Entomological News 40: 322), *Sarcophaga elongata* Aldrich (1916, *ibid.,* p. 198), *Sarcophaga gracilis* Aldrich (1916, *ibid.,* p. 202), *Sarcophaga juliaetta* Aldrich (1916, *ibid.,* p. 200), *Sarcophaga lilliputiana* Dodge (1967, Pacific Insects 9: 684), *Sarcophaga perissa* Reinhard (1952, Canadian Entomologist 84: 145), *Sarcophaga perspicax* Aldrich (1916, *ibid.,* p. 201), *Sarcophaga statuta* Reinhard (1952, *ibid.,* p. 144), *Sarcophaga thatuna* Aldrich (1916, *ibid.,* p. 196), and *Sarcophaga vancouverensis* Parker (1918, Canadian Entomologist 50: 122) should all be included as **new combinations** in *Neosarcophaga* Shewell.

I thank Drs. J. M. Cumming and J. R. Vockeroth of the Centre for Land and Biological Resources Research for reviewing the manuscript.

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Note

An Overlooked Paper on Heteroptera by N. A. Kormilev

In the recent bibliography of the works of Nicholas A. Kormilev, by R. C. Froeschner (1995, Proceedings of the Entomological Society of Washington 97: 515–547), one publication was overlooked: Kormilev, N. A. 1929. A contribution to the study of Hemiptera–Heteroptera of Jugoslavia. (In Serbian). Acta Societatis Entomologicae Jugoslavensis 3–4: 79–91.

This paper was noticed by J. A. Slater (1964, A catalogue of the Lygaeidae of the world. Univ. Conn., Storrs, Vol. II, pp. 779–1668; p. 1572) but missed by other authors, including those providing catalogs with comprehensive bibliographies. There are no major taxonomic changes or new taxa proposed in this work, which may be why it has been commonly overlooked.

Kormilev's 1929 paper deals with the families Acanthosomatidae, Pentatomidae, Plataspidae, Scutelleridae, Thyreocoridae, Stenocephalidae, Rhopalidae, Coreidae, Berytidae, Pyrrhocoridae, Piesmatidae, Lygaeidae, Reduviidae, Cimicidae, Anthocoridae, Miridae, Hydrometridae, Veliidae, Gerridae, Saldidae, Naucoridae, Nepidae, Notonectidae, and Corixidae (as recognized by Carver, M., G. F. Gross and T. E. Woodward. 1991, Hemiptera, vol. 1, pp. 429–509 *In* The Insects of Australia, Edition II, CSIRO, Canberra). It lists taxa for the region, restates some already existing synonymies, and gives distributions.

Several years ago I purchased from Dr. Kormilev his personal set of his own works, supposedly complete. When asked about his 1929 paper, he wrote: "The paper which you mentioned was my first attempt to describe what I had at that time. I didn't get page proof and there were mistakes, so I don't count it and I don't have it now. I started with #1 in 1936, and that paper you have."

All of us who have published extensively are painfully aware that, no matter how embarrassing or unfortunate, a paper published in the open literature cannot be withdrawn or suppressed.

I am grateful to Carl W. Schaefer for help with a foreign language problem.

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98(2), 1996, pp. 377–379

Obituary

Theodore Lemuel Bissell
December 9, 1899–September 22, 1992

Theodore L. Bissell was a respected member of the Entomological Society of Washington, and his graciousness and good humor endeared him to all who knew him.

Ted was born in St. Mary's, Ohio. His father was a photographer. He died when Ted was a small boy. His mother, with four young children, moved to Westover in Somerset County on Maryland's Eastern Shore to be near her family. Ted biked to high school in Princess Anne where he graduated in 1916 at 16 years of age. He then came to College Park where the future University of Maryland had just had its name changed from Maryland Agricultural College to Maryland State College. Military training was emphasized at that time, and Ted became a cadet. During the war years, he was actually considered an enlistee in the U.S. Army and was called up to an army base in New York for summer camp, but the war ended and he returned to Maryland where he proudly held the rank of cadet captain. After graduation from the University of Maryland in 1920, Ted remained a member of the "Twenties Crowd," a loosely affiliated group of graduates who came together until the 1980's at University functions, including football games, to represent their decade.

Following graduation, Ted was employed by the U.S. Department of Agriculture, Bu-

reau of Entomology, as a plant quarantine inspector in Hawaii. To help control pest problems, he accompanied marines to shoot wild goats in the mountains. His lasting impression of that phase of his career was the inordinate number of boots he wore out on the lava rocks.

In 1924, he married Isabel Veitch and moved to Georgia where he joined the staff of the Georgia Agricultural Experiment Station. He was stationed at Thomasville, Barnesville, and finally at "Experiment" near Griffin. His principal assignment concerned insects affecting pecans. In 1936, he went to Ithaca, N.Y., and was awarded the M.S. degree by Cornell University. His thesis was entitled "Field Experiments with Hydrated Lime Spray as a Repellent for the Pecan Weevil, with Observations on the Nature of Weevil Infestations." He was cofounder of the Georgia Entomological Society, and, during this period, his three children were born: Sarah (Ervin), William, and Robert.

Ted returned to the University of Maryland in 1947, serving as Extension Entomologist until his retirement in 1970. He assembled information and made recommendations for controlling agricultural and urban insect pests, identified thousands of insect specimens for extension agents and the general public, prepared many Extension "Fact Sheets," and, for many years, released the weekly "Insect Notes" during the growing season. Ted was a leader in attempting to educate growers so that satisfactory insect control could be obtained with minimum use of insecticides. It was during this period that Ted was an active member of the Entomological Society of Washington and served as President in 1955. He was also a long-time member of the Entomological Society of America and a charter member of the Maryland Entomological Society.

Ted was always ready to help fellow entomologists, answer questions, and fill in background on entomological subjects. He was interested in history, entomological and especially Maryland history. He published "A History of Entomology at the University of Maryland" in the *Bulletin of the Entomological Society of America* 6(2): 80–85, 1960. During all of his contacts with entomologists and the general public, his friendly manner stood out—but he was given to using two expletives: "Bingo!" and "Aye yi!" The former was used as an affirmative and the latter as he recovered following numerous close calls while driving around the state.

When Ted was anticipating retirement in 1970, he began planning to travel in Europe with his church group. These plans necessitated a passport, and it was only then that he discovered his real name was Raymond. He had been called Ted after Theodore Roosevelt because of his activity and daring as a child. With his usual good humor he had his name officially changed, and he had another good story to tell.

After retirement, Ted taught part-time for the Institute of Applied Agriculture at the University of Maryland. This activity rekindled his interest in aphid taxonomy and morphology. He was modestly proud of his fifty-five year career as a researcher, extension entomologist, and teacher. His community service included tenure on the town council of University Park for eight years, a lengthy term as program chairman of his church's men's group where the Methodist men learned more about entomology than they had bargained for, and faithfully delivering Meals on Wheels to elderly shut-ins who (also) could not drive. On his eighty-third birthday, Ted was elected to be one of only four honorary members of the Entomological Society of Washington. His wife died in 1964. He is survived by three children, ten grandchildren, and 17 great grandchildren.

William E. Bickley *and* F. Eugene Wood, *University Park, MD.*

Publications on Aphids

Louise M. Russell and Manya B. Stoetzel (Systematic Entomology Laboratory, PSI, ARS, U.S. Department of Agriculture, Beltsville, MD) have provided the following list of publications by Ted Bissell dealing with aphids. Numerous publications on other subjects are omitted.

1928

An interesting aphid of the pecan. Journal of Economic Entomology 21: 551–553.

1931

Pecan aphids, pp. 37–41. *In* Moznette, G. F., et al., Insects of the pecan and how to combat them. United States Department of Agriculture, Farmers' Bulletin 1654: 36–43.

1932

The identity of the black pecan aphid, *Melanocallis caryaefolia* (Davis). Annals of the Entomological Society of America 25: 730–735.

1937

The green bug, *Toxoptera graminum* Rond. Georgia Experiment Station Annual Report 49: 48–50.

1940

Black pecan aphid, p. 13. *In* Moznette, G. F., et al., Insects and diseases of the pecan and their control. United States Department of Agriculture, Farmers' Bulletin 1829: 1–70.

1946

Black pecan aphid, pp. 20–21. *In* Growing pecans in Georgia. Georgia Agricultural Extension Service Bulletin 501: 1–25. (With G. H. Firor.)

1962

Aphids on strawberry in Maryland—species, seasonal abundance, and control. Transactions of the Peninsula Horticultural Society 52: 45–52. (With W. S. Murray and J. C. Kantzes.)

1969

The subcoxa of the aphid hind leg (Homoptera: Aphididae). Proceedings of the Entomological Society of Washington. 71: 133–140.

1970

A list of the aphids of the District of Columbia, Maryland, and Virginia. University of Maryland Agricultural Experiment Station, Miscellaneous Publication 770, 129 pp. (With M. D. Leonard.)

1973

Aphid births (Homoptera, Aphididae). Proceedings of the Entomological Society of Washington 75: 416–418.

1975

A strange aphid form. Proceedings of the Entomological Society of Washington 77: 504.

1975

An unusual aphid on African violet. Cooperative Economic Insect Report, United States Department of Agriculture 25: 605.

1978

Aphids on Juglandaceae in North America. University of Maryland Agricultural Experiment Station, Miscellaneous Publication 911, 78 pp.

1981

Collecting aphids from walnuts and hickories through the years. Maryland Entomologist 2: 7–9.

1982

A new species of aphid, genus *Monelliopsis* on pecan. Journal of the Georgia Entomological Society 18: 71–77.

1986

The hickory aphid, *Protopterocallis fumipennella* (Fitch) and its junior synonym, *P. canadensis* Richards, new synonymy (Homoptera: Aphididae). Proceedings of the Entomological Society of Washington 88: 571.

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Reports of Officers

Editor

Seventy-seven articles, eleven notes, and one book review were published in 1995 for a total of 906 pages. This is a decrease of one article and five book reviews, but an increase of three notes and 126 pages over 1994.

In addition, three memoirs were published. These include "Biology and Phylogeny of Curculionoidea," edited by R. S. Anderson and C. H. Lyal, "A Revision of the Genus *Ceratopogon,*" by A. Borkent and W. L. Grogan, Jr., and "The Genera of Beridinae (Diptera: Stratiomyidae)," by N. E. Woodley, the latter of which was edited by incoming editor David R. Smith. I also should point out that the April issue of the *Proceedings* was dedicated to the memory of J. C. M. Carvalho for his outstanding contributions to the study of the heteropteran family Miridae.

I thank Gary L. Miller for his continuing efforts to acquire informative book reviews, A. G. Wheeler, Jr., for his editorial expertise needed to produce Memoirs 14 and 15, and to F. Christian Thompson for much time spent to produce these memoirs at a significant cost saving to the Society. Marie Blair provided much assistance in routing manuscripts and correspondence. Without her aid, my job would have been enormously more difficult.

Finally, I am grateful to the many reviewers for their time-consuming and constructive reviews. Their contributions are essential to insuring the high quality of papers published in the *Proceedings.*

Thomas J. Henry, *Editor*

Membership Chair

List of New Members for 1995

Harry Brailovsky
William A. Bruce
Claudio Carvalho
Maria del Carmen Coscarón
Stephen Gaimari
Eric L. Johnson
Lodewyk Kuenen
E. C. Masteller
Keith Pike
Austin B. Richards
John Rumph
Osmanu Tadauchi
J. R. Vockeroth

Letters were sent to each of the applicants after his/her name was read at a regular meeting. Several letters were sent in response to requests for membership applications. There were six less new members this year than last year. All members are urged to invite their colleagues and students to become members of the Society.

M. Alma Solis, *Membership Chair*

President-Elect

The 1995 Annual Banquet was held on 31 May 1995 at the Associates Court of the National Museum of Natural History in Washington, D.C. One hundred two tickets were sold, of which nine were to students. Members and guests of the Entomological Society of Washington were joined by members of the Maryland Entomological Society. The Master of Ceremonies for the evening was Dr. Manya Stoetzel who kept things moving along. The after dinner speaker was Dr. Gary Umphrey of the University of Western Ontario who spoke on "Analyzing the literature of insect fiction: Themes, dreams, schemes, and screams."

Receipts from the sale of tickets were $2145, however the actual cost of the event was $3023.75. The difference was subsidized by the Society and included complimentary dinners for the speaker and his wife, honorarium, and postage. Dr. Ray Gagné was the most outstanding ticket salesperson selling 46 tickets.

Ralph P. Eckerlin, *President-Elect*

SUMMARY FINANCIAL STATEMENT FOR 1995

	General Fund	Special Publications Fund	Total Assets
Assets: November 1, 1994	$12,695.51	$118,733.57	$131,429.08
Total Receipts for 1995	65,436.27	7,284.70	72,720.97
Total Disbursements for 1995	76,986.06–	16,040.67–	93,026.73–
Assets: October 31, 1995	1,145.72	109,977.60	111,123.32
Net Changes in Funds	$11,549.79–	$ 8,755.97–	$ 20,305.76–

Audited by the Auditing Committee, December 5, 1995, consisting of Ronald W. Hodges, Michael E. Schauff, and F. Christian Thompson, Chairman. Presented to the membership at the meeting of December 7, 1995.

Respectfully submitted,
Norman E. Woodley, *Treasurer*

PROC. ENTOMOL. SOC. WASH.
98(2), 1996, pp. 382–384

Society Meetings

1004th Regular Meeting—May 31, 1995

The 1004th meeting was the Annual Banquet of the Society. See Reports of Officers, President-Elect.

1005th Regular Meeting—October 5, 1995

The meeting was called to order at 8:04 pm by President John Neal in the Waldo Schmitt Room, National Museum of Natural History, Washington, D.C.

Alma Solis, Membership Chair, read five applications for membership: Dr. Claudio Carvalho (Universidade Federal do Paraná; interests are biosystematics of muscoid flies and theory of biological classification); Dr. Maria del Carmen Coscarón (Departmento Cientifico de Entomologia, Museo de La Plata, Argentina; interests are systematics, phylogeny, and biogeography of Heteroptera); Dr. Keith Pike (Washington State University, Agriculture Experiment Station); Dr. Osmanu Tadauchi (Entomological Laboratory, Kyushu University; interests are systematics of Apoidea and computer taxonomy); and Dr. E. C. Masteller (Pennsylvania State University, Erie). No new members were present.

President-Elect Ralph Eckerlin deferred comments on the June banquet to a later date.

President Neal reported that he has found inconsistencies in the bylaws, other than those noted by the Bylaws Committee. For instance, committees are appointed on an as-needed basis rather than as standing committees. He announced appointment of the auditing committee consisting of Mike Schauff, Ron Hodges, and Chris Thompson and the nominating committee consisting of E. Eric Grissell, Douglass R. Miller, and Wayne N. Mathis. The Nominating Committee has several key vacancies to fill, those of Recording Secretary, Treasurer, and Program Chair. Norm Woodley, who has done an outstanding job as Treasurer for the past ten years, will step down at the end of this term. Tom Henry, who has done an excellent job as Editor, will also step down, but an Associate Editor is in place to take over. Before moving to California, Nathan Schiff arranged for speakers at the two remaining meetings this year. Nathan did an outstanding job during his term as Program Chair. He and John M. Heraty made the 1000th meeting of the Society a memorable event.

The speaker for the evening was Nathan Schiff, outgoing Program Chair. His talk, entitled "Sawfly Sayonara," was on his favorite topic, sawfly research. A chemist, who had studied a few species of ants and bees which are secondary herbivores, assumed that all hymenopterans lack the ability to synthesize cholesterol from sterols in their food. From his previous research, Nathan knew that sawflies, which are primary herbivores, can synthesize cholesterol from sterols. Nathan and the chemist collaborated to conduct a meaningful study.

After the talk, Dave Smith introduced a visiting hymenopterist, Marcello T. Tavares from Brazil. Paul Spangler noted that Ted Spilman, a long-time active member and Past President of the Society, is seriously ill.

President Neal asked if there were any corrections to be made to the minutes read this evening. There were none, so the minutes were approved as read. Dr. William Bickley noted that Doyle Reed, former President of the Society, recently died at the age of 94.

The meeting was adjourned at 9:07 PM. Refreshments were provided by Nathan Schiff.

Holly B. Williams for Darlene D. Judd,
Recording Secretary

1006th Regular Meeting—November 2, 1995

The meeting was called to order at 8:03 pm by President John Neal in the Waldo Schmitt Room, National Museum of Natu-

ral History, Washington, D.C. Fourteen members and guests were present.

Membership Chair Alma Solis reported on three applications for membership to the Society: Dr. Harry Brailovksy (Universidad Nacional Autonoma de Mexico; interests are Heteroptera); Mr. Austin B. Richards (Lakewood, Colorado; interests are taxonomy of aquatic insects, especially whirligig beetles, Gyrinidae); and Mr. John Rumph (Department of Entomology, Washington, State University, Pullman; interests are Diptera, Chamaemyiidae, and general entomology). No new members were present.

President Neal noted that the December meeting is the annual meeting of the Society when officers for 1996 will be elected. Bylaws Committee Chair Dave Smith reported that he and Norm Woodley were reviewing proposed changes in the bylaws of the Society. The proposed changes need to be approved by the Executive Committee, and, if approved, will be presented at the December meeting and voted on at the January meeting. For a vote to be taken at the January meeting, a quorum of 20 members must be present. As Associate Editor of the Society, Dave Smith noted that two new memoirs have been published: "Biology and Phylogeny of Curculionoidea" and "A Revision of the Genus *Ceratopogon*." Another memoir "The Genera of Beridinae (Diptera: Stratiomyidae)" is near publication. Also, the Society publication "A Handbook of the Families of Nearctic Chalcidoidea (Hymenoptera)" will be revised and reprinted.

Nominating Committee Chair Wayne Mathis presented the committee's recommendations for officers of the Society:

President—Ralph P. Eckerlin
President-Elect—M. Alma Solis
Recording Secretary—Darlene D. Judd
Corresponding Secretary—Hollis B. Williams
Custodian—Gary L. Miller
Treasurer—Michael G. Pogue
Program Chair—David G. Furth
Membership Chair—David Adamski
Editor—David R. Smith
Past President—John W. Neal, Jr.

President Neal thanked the members of the Nominating Committee for their efforts and noted that the slate of candidates will be voted on at the December meeting.

No old business or new business was presented.

For notes and exhibitions, Dr. Bickley mentioned that three members of the Society, Wayne Mathis, Elaine Hodges, and George Venable, were cited for awards at the recent National Museum of Natural History Staff Day. E. S. Saugstad exhibited a photograph in the annual calendar of North Dakota: a tiger swallowtail was misidentified as a monarch butterfly.

Dr. Jeff Shultz, Department of Entomology, University of Maryland, gave a talk entitled "Evolution of Locomotion in Arachnids and Centipedes." Dr. Shultz and other workers have studied the biomechanics of locomotion in various arthropods, including centipedes, horseshoe crabs, and different arachnids (spiders, harvestmen, scorpions, pseudoscorpions). Dr. Shultz explained the results of some studies and compared the propulsion systems used in these groups.

One guest, Diane Mathis, was introduced.

President Neal adjourned the meeting at 9:05 PM. Refreshments were provided by Alma Solis.

Holly B. Williams for Darlene D. Judd,
Recording Secretary

1007th Regular Meeting—December 7, 1995

The meeting was called to order at 8:00 pm by President John Neal in the Waldo Schmitt Room, National Museum of Natural History, Washington, D.C. Twenty members and 14 guests were present. The minutes of the November meeting were read by Paul Spangler. Members made two

corrections to the minutes which were approved as amended.

Membership Chair Alma Solis received no applications for membership the past month.

President Neal presented a summary report on the state of the Society and the work of the retiring officers. He discussed business from the recent Executive Committee meeting. Reports were given by Treasurer Norm Woodley and Editor Tom Henry. Suggested changes to the bylaws were presented in writing by Norm Woodley and were discussed in detail. A modified form of the changes were accepted by voice vote of the Executive Committee for presentation to the membership. A vote on the changes will be at the regular January meeting. President-Elect Ralph Eckerlin reported on the spring banquet. Because the January meeting date was so close to New Years Day, the Executive Committee voted to hold the meeting on the second Thursday, January 11.

Wayne Mathis presented the Summary Financial Statement for 1995 prepared by Treasurer Norm Woodley. This was approved by the Auditing Committee consisting of Mike Schauff, Ron Hodges, and Chris Thompson, Chair.

President Neal read the report of the Editor, Tom Henry, for 1995. Seventy-seven regular papers, 11 notes, and one book review for a total of 906 pages were published in the *Proceedings*. By the end of the year, three memoirs will be published.

A report of the Bylaws Committee, consisting of Dave Smith and Norm Woodley, was given. Dave Smith presented and distributed copies of the proposed changes to be voted on at the next meeting.

Wayne Mathis, Chair of the Nominating Committee also consisting of E. Eric Grissell and Douglass Miller, presented the slate of officers as given at the November meeting. President Neal asked for nominations from the floor. There were no further nominations, and Bill Bickley made a motion that the slate of candidates be elected by acclamation. The motion was seconded by Wayne Mathis and the slate of officers was accepted by unanimous vote.

The speaker for the evening was Dr. Ted Suman, Science Division, Anne Arundel Community College. His talk was titled "Archaeological and Forensic Use of Insects."

Honorary President Curt Sabrosky and Past President Bill Bickley escorted President-Elect Ralph Eckerlin to the lectern. President Neal thanked past officers for such a successful year - e.g. the success of the 1000th meeting celebration, the spring banquet, and progress to update the bylaws. He transferred the gavel to the President-Elect. President Eckerlin adjourned the meeting at 9:20 PM. Refreshments were provided by Ralph Eckerlin.

Holly B. Williams for Darlene D. Judd,
Recording Secretary

PUBLICATIONS FOR SALE BY THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

Miscellaneous Publications

Cynipid Galls of the Eastern United States, by Lewis H. Weld. 124 pp. 1959	$ 5.00
Cynipid Galls of the Southwest, by Lewis H. Weld. 35 pp. 1960	3.00
Pictorial Key to Species of the Genus *Anastrepha* (Diptera: Tephritidae), by George C. Steyskal. 35 pp. 1977	1.50
Taxonomic Studies on Fruit Flies of the Genus *Urophora* (Diptera: Tephritidae), by George C. Steyskal. 61 pp. 1979	2.00
A Handbook of the Families of Nearctic Chalcidoidea (Hymenoptera), by E. Eric Grissell and Michael E. Schauff. 85 pp. 1990	10.00

Memoirs of the Entomological Society of Washington

No. 1.	The North American Bees of the Genus *Osmia,* by Grace Sandhouse. 167 pp. 1939	$15.00
No. 2.	A Classification of Larvae and Adults of the Genus *Phyllophaga,* by Adam G. Boving. 95 pp. 1942	(out of print)
No. 3.	The Nearctic Leafhoppers, a Generic Classification and Check List, by Paul Wilson Oman. 253 pp. 1949	15.00
No. 4.	A Manual of the Chiggers, by G. W. Wharton and H. S. Fuller. 185 pp. 1952	15.00
No. 5.	A Classification of the Siphonaptera of South America, by Phyllis T. Johnson. 298 pp. 1957	15.00
No. 6.	The Female Tabanidae of Japan, Korea and Manchuria, by Wallace P. Murdoch and Hirosi Takahasi. 230 pp. 1969	15.00
No. 7.	Ant Larvae: Review and Synthesis, by George C. Wheeler and Jeanette Wheeler. 108 pp. 1976	11.00
No. 8.	The North American Predaceous Midges of the Genus *Palpomyia* Meigen (Diptera: Ceratopogonidae), by W. L. Grogan, Jr. and W. W. Wirth. 125 pp. 1979	12.00
No. 9.	The Flower Flies of the West Indies (Diptera: Syrphidae), by F. Christian Thompson. 200 pp. 1981	10.00
No. 10.	Recent Advances in Dipteran Systematics: Commemorative Volume in Honor of Curtis W. Sabrosky. Edited by Wayne N. Mathis and F. Christian Thompson. 227 pp. 1982	11.00
No. 11.	A Systematic Study of the Japanese Chloropidae (Diptera), by Kenkichi Kanmiya. 370 pp. 1983	18.00
No. 12.	The Holarctic Genera of Mymaridae (Hymenoptera: Chalcidoidae), by Michael E. Schauff. 67 pp. 1984	5.00
No. 13.	An Identification Manual for the North American Genera of the Family Braconidae (Hymenoptera), by Paul M. Marsh, Scott R. Shaw, and Robert A. Wharton. 98 pp. 1987	18.00
No. 14.	Biology and Phylogeny of Curculionoidea, edited by R. S. Anderson and C. H. C. Lyal. 174 pp. 1995	25.00
No. 15.	A Revision of the Genus *Ceratopogon* Meigen (Diptera: Ceratopogonidae), by A. Borkent and W. L. Grogan, Jr. 198 pp. 1995	25.00
No. 16.	The Genera of Beridinae (Diptera: Stratiomyidae), by Norman E. Woodley. 231 pp. 1995	25.00

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of the

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of WASHINGTON

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THE

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OF WASHINGTON

ORGANIZED MARCH 12, 1884

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PLEASE SEE P. 615 OF THIS ISSUE FOR INFORMATION REGARDING PREPARATION OF MANUSCRIPTS.

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NOTES ON *OENOPIA* MULSANT (COLEOPTERA: COCCINELLIDAE)

NATALIA J. VANDENBERG

Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture, % National Museum of Natural History, MRC-168, Washington, DC 20560, U.S.A.

Abstract.—*Cycloneda pusilla* Weise is transferred to *Oenopia* Mulsant (**n. comb.**), a lectotype for the species is designated, and the type locality is corrected from Prov. Entre Rios, Argentina, to Kinabalu, Sabah, Malaysia (Borneo). *Coelophora parvula* Sicard is placed as a **new synonym**. Some of the taxonomic literature on *Oenopia* is reviewed. Key characteristics of the genus are discussed and other relevant remarks presented. This is the second species of *Oenopia* which has been incorrectly listed in catalogs and checklists of the New World fauna.

Key Words: Coccinellini, *Oenopia, Coccinella, Cycloneda,* synonyms, Neotropical, Malaysia, misplaced taxa.

Examination of some of Weise's type material from the Museum für Naturkunde der Humboldt-Universität, Berlin (ZMHB) revealed a case of erroneous and startling generic assignment of a small hemispherical lady beetle: *Cycloneda pusilla* Weise. Misclassification of species in the Neotropical genus *Cycloneda* (Coccinellinae; Coccinellini) is not in itself unexpected. In the most recent checklist for this region (Blackwelder 1945), nearly 95% of the species placed in *Cycloneda* are misassigned, while more than half of the presently recognized members are incorrectly listed under *Coccinella* (Vandenberg 1992, Gordon and Vandenberg 1993). What is remarkable about the species in question is not that it was misclassified, but that it has been listed as a member of the Neotropical fauna for nearly 90 years (Weise 1906, Korchesky 1932, Blackwelder 1945, Mader 1958) while in fact representing a senior synonym of a species of *Oenopia* known exclusively from islands of the Malaysian Province (Flores and "Borneo").

The present paper gives a brief overview of the Old world genus *Oenopia,* makes a lectotype designation for *C. pusilla* Weise, recognizes the new combination *Oenopia pusilla* (Weise), presents a new synonymy and its justification, corrects the erroneous type locality, and draws attention to a similar occurrence of a misplaced *Oenopia* species.

OVERVIEW OF *OENOPIA* MULSANT

Oenopia is an Old World genus of aphidophagous coccinellines recorded from Europe, Asiatic Russia, Africa, India, Sri Lanka, China, Japan, Philippines, New Guinea, and Australia (Pope 1988). Recent revisionary work includes Iablokoff-Khnzorian (1982; Palearctic), Xibei and Shaanxi (1985; China) Fürsch (1988; Africa) and Pope (1988; Australia). Members of the genus present a very diverse facies, from rounded convex forms at one extreme (previously classified in *Gyrocaria* Timberlake) to elongate flattened forms at the other (formerly *Synharmonia* Ganglbauer). The nu-

merous generic names that arose due to this morphological lability were synonymized by Iablokoff-Khnzorian (1982), and more recently the genus *Paramulsantina* Hoang (1982), proposed for two Vietnamese species, was synonymized by Jadwiszczak and Pokojowczyk (1990). Despite external differences, members of *Oenopia* are strongly united by characteristics of the genitalia of both sexes (Figs. 1, 2, 5). The female genitalia have a very unusual and consistent form of spermatheca with a highly elongate, apically swollen ramus; short flexible sperm duct, and small diagnostically shaped infundibulum. The male genitalia are more variable and can be used for species determination, but they typically have arched parameres and an upturned, medially notched basal lobe.

Oenopia pusilla (Weise), New Combination

(Figs. 3, 4, 5)

Cycloneda pusilla Weise, 1906:219; Korchefsky 1932:285; Blackwelder 1945: 452; Mader 1958:246.

Coelophora parvula Sicard, 1912:510. **New synonymy**.

Gyrocaria parvula: Bielawski, 1964:86–88.

Oenopia parvula: Iablokoff-Khnzorian 1982:400.

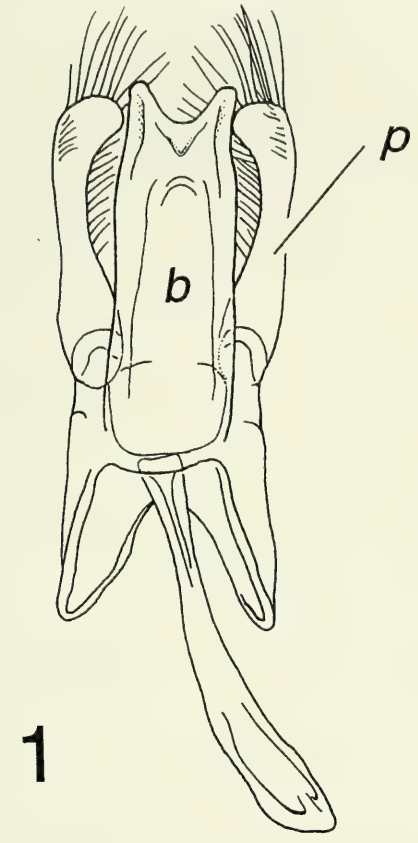
Lectotype of *Cycloneda pusilla* Weise: female (present designation), Entre rios [white paper]/Entre Rios Heyne[green paper]/Cycloneda pusilla m [white paper]. (ZMHB).

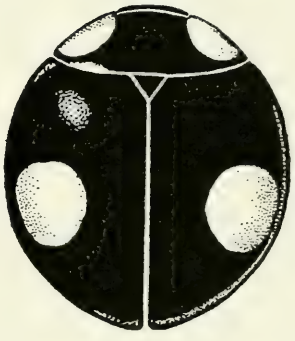
Corrected type locality: Kinabalu, Sabah, Malaysia (Borneo).

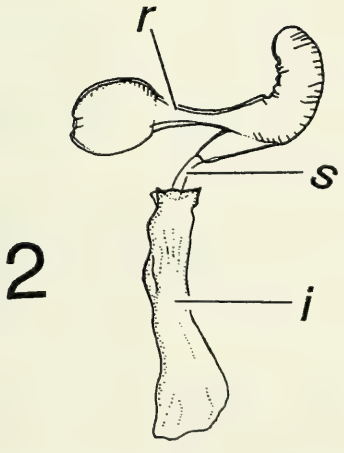
The original description of *Cycloneda pusilla* Weise appears as a footnote in a publication on some Argentine beetles in the collection of Bruch (Weise 1906), but no examples of this species are to be found among the other type material from the Bruch collection housed at Museo Argentino de Ciencias Naturales, Buenos Aires (A. Bachmann, curator, pers. comm.). Weise's description specified that the species was from the collection of "Rolle," therefore probably never part of the Bruch collection at all and hence its treatment as a footnote. A single female of *C. pusilla* labeled as specified above was located at the Humbolt Museum (ZMHB). The second label bears the name "Heyne" rather than "Rolle", but according to Horn (1937), the brothers A. and M. Heyne (London) were insect sellers from whom H. Rolle (Berlin) purchased specimens. The bottom label is in Weise's distinctive script and signed with an "m [=mihi]" which was often his habit, so there is little doubt that the specimen is the holotype or at least part of the original type series. To resolve the uncertainty, the specimen is designated as lectotype. The lectotype is in perfect agreement with the type description in size, coloration and markings.

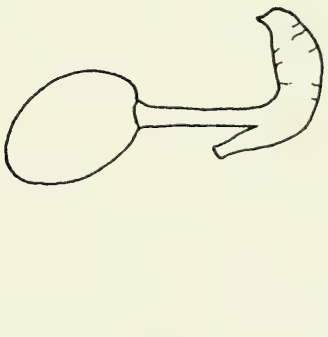
The synonymy of *C. parvula* Sicard with *C. pusilla* is based upon comparison of the lectotype with material in the National Museum of Natural history, in particular a series of four specimens identified as *C. parvula* by R. Korchefsky, including a card mounted pair labeled "cum typ. comp." *Cycloneda pusilla* is in full agreement with both the original description of *C. parvula* and its redescription by Bielawski (1964). The latter author examined a specimen determined by Sicard which was collected at the type locality (Kinabalu, Sabah, Malaysia). Bielawski's habitus drawing of a male specimen matches the lectotype of *C. parvula* except for the pale head coloration which is a male characteristic.

In accordance with Recommendation 72H of the International code of Zoological Nomenclature (1985), a "statement of a type locality that is found to be erroneous should be corrected." The type locality specified by Weise (1906) for *C. pusilla* was "Prov. Entre Rios". This locality is in Argentina but erroneously placed in Brazil by Korchefsky (1932). Other "Entre Rios" localities are in Bolivia (1), Brazil (3), Mozambique (1), and Colombia (1). None of these alternatives appear to be a









Figs. 1–2. Characteristic form of genitalia in *Oenopia* spp. (*Oenopia conglobata.* 1, Male genitalia (b = basal lobe; p = paramere). 2, Female genitalia (r = ramus of spermatheca; s = sperm duct; i = infundibulum). Figs. 3–5. Morphological structures of *Oenopia pusilla,* lectotype. 3, Anterior view of pronotum. 4, Dorsal habitus. 5, Spermatheca.

reasonable type locality for *C. pusilla,* a species known only from two islands of the Malaysian province: Borneo and Flores (Bielawski 1964). Interestingly, the upper label on the lectotype does not capitalize the "rios" in "Entre rios" which may indicate that the specimen was captured "between rivers" (e.g. any two rivers) and not necessarily in a place with that name. The corrected type locality is adopted from that of the junior synonym.

This is the second case of an *Oenopia* species mistakenly attributed to the New World fauna (Vandenberg 1992). Weise (1904) correctly pointed out that *Coccinella maculosa* Gorham, illustrated and described from Oaxaca, Mexico (Gorham 1891), is identical to the common European species *Oenopia conglobata.* Unfortunately, modern works have failed to pick up on the synonomy, or simply did not accredit Weise's discovery since several other synonymies proposed in the same work were erroneous. Korchefsky (1932) and Blackwelder (1945) included *C. maculosa* in their listings of New World fauna, perpetuating the misassignment. *Oenopia conglobata* has not resurfaced in the Western Hemisphere for more than 100 years since *C. maculosa* was described from Oaxaca, Mexico. It has been released many times in North America over the last 40 years (Gordon 1985, Gordon and Vandenberg 1991), but apparently never established. Hence, the case of *C. maculosa* appears to be a simple one of mislabeling.

Acknowledgments

The author is grateful to Manfred Uhlig (ZMHB) for loan of the type specimen of *C. pusilla*; to F. C. Thompson, Systematic Entomology Laboratory, U.S.D.A., Washington, D.C., for assistance with the literature and interpretation of specimen labels; and to F. C. Thompson and A. L. Norrbom, same affiliation, and T. Carlow and W. E. Steiner, Department of Entomology, Smithsonian Institution, Washington, D.C., for their thoughtful review of the manuscript.

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DESCRIPTION OF THE MALE AND VARIATION IN *BOLBODIMYIA GALINDOI* FAIRCHILD (DIPTERA: TABANIDAE), AND A REVISED KEY TO SPECIES OF *BOLBODIMYIA*

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Abstract.—The male of *Bolbodimyia galindoi* Fairchild from Costa Rica is described for the first time and compared with the female. Variation in the color of *B. galindoi* throughout its known range from Costa Rica to Colombia is discussed. A revised key to the genus *Bolbodimyia* is provided.

Key Words: Diptera, Tabanidae, variation, *Bolbodimyia galindoi,* Neotropical region, key to species of *Bolbodimyia*

Recent examination of Tabanidae from the National Museum of Natural History collection (USNM), the Instituto Nacional de Biodiversidad collection (INBIO) in Costa Rica, and the Florida State Collection of Arthropods (FSCA), has turned up two males and five females of *Bolbodimyia galindoi* Fairchild from Costa Rica, a species until now represented in collections by only three females, two from Panama (the type locality and another site) and one from Colombia. The females show considerable variation not mentioned by Fairchild (1964) in his original description or by Wilkerson (1979) in his treatment of Tabanidae from Colombia. The male of *B. galindoi* is described here and variation in females is discussed.

The genus *Bolbodimyia* Bigot was last revised by Stone (1954). Since that time, three additional species have been described, and the genus is currently represented by 13 described species. Therefore, in addition to describing the male of *Bolbodimyia galindoi* Fairchild, and variation in that species, it is appropriate to provide a new key to species to facilitate identification. *Bolbodimyia* is a Neotropical genus occurring from Argentina to Mexico, with one species extending into central Arizona and New Mexico. Most species are found in Central and Northern South America (Fairchild and Burger 1994).

Bolbodimyia can be distinguished from other genera of Tabanidae by the following combination of characteristics: body black or orange and black; subcallus strongly inflated (Figs. 2, 3) and shining black or yellow and black; antennal scape strongly inflated and bulbous (Fig. 3), shining black; wing partly to entirely blackened except for hyaline apex; vein R_4 strongly curved upward; tibiae distinctly inflated; male with upper ⅔ of eye bearing enlarged facets that are strongly differentiated from area of small facets below, area of small facets extending around posterior margin of eye to vertex.

Little is known of the immature stages, except for two species, *Bolbodimyia atrata* (Hine), described by Burger (1977), and *B. bermudezi* Tidwell and Philip, described by Tidwell and Philip (1977). The known immature stages occur in moss in waterfalls and rapidly flowing streams. The males of six species are known, *B. atrata, B. brunneipennis* Stone, *B. galindoi, B. lampros* Philip and Floyd, *B. lateralis* Kröber, and

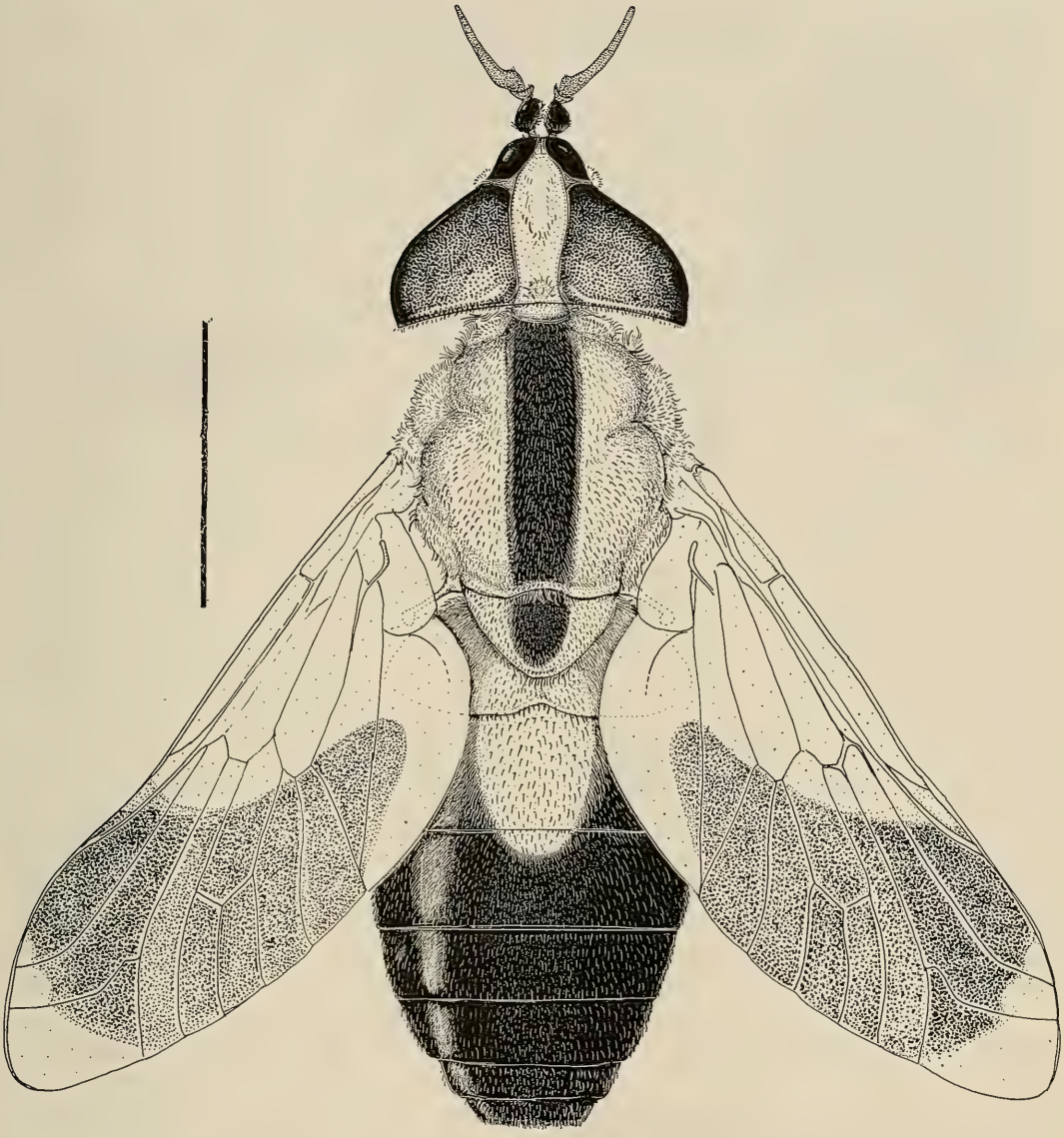

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Fig. 1. Adult female of *Bolbodimyia galindoi* - dark form, dorsal view. Scale bar = 4.0 mm.

B. philipi Stone, and are similar to the females in coloration. The female of *B. lampros* is undescribed; the male was described by Philip and Floyd (1974) from Mexico.

Bolbodimyia galindoi Fairchild
(Figs. 1–5)

Bolbodimyia galindoi Fairchild, 1964: 172, fig. 5; Wilkerson, 1979: 232–234; Fairchild, 1986: 37.

Male.—Body length 12.6–13.6 mm, wing length 9.6–10.0 mm. Similar to female except for usual sexual differences and the following characteristics. Eyes with facets of upper ⅔ distinctly enlarged, green

with darker center, strongly differentiated from black area of small facets below, smaller facets extended around posterior margin of eye to vertex. Subcallus strongly inflated, shining black dorsally with median yellow to reddish band and yellow to reddish ventrally. Apical palpomere of maxillary palpus relatively slender and elongate, 3 times longer than broad, acutely pointed apically, reddish brown basally, dusky apically, bearing mixed orange and black hairs.

Mesoscutum orange, median dark stripe reduced to pale brown shadow, entirely orange haired. Scutellum shining light brown with orange lateral margins, orange haired. Legs entirely black except basal ⅓ of anterior forecoxae orange and orange haired. Wing (Fig. 5) with membrane and veins bright orange-yellow, except for large jet-black subapical patch extending diagonally from vein R_1 at distal margin of stigma through angular curve of vein R_4 and along vein R_5 to posterior margin of wing in cell R_4, wing apex yellowish, posterior half of wing from vein R_5 to anal cell orange-yellow, not darkened as in female.

Abdomen varying from shining black, overlain with thin gray tomentum, entirely orange haired to black with broad median brown streak on tergites 1–3, tergites 5–6 mostly to entirely yellow-brown, and sternites 1–5 irregularly yellowish brown and black.

COSTA RICA: Guanacaste, Parque Guanacaste Nacional, Estación Pitilla, Río Orosí, 10.991 N, 85.428 W, 19–20. vi. 1988, el. 700 m, C. M. & O. S. Flint, Holtzenthal, 1 ♂ (USNM); Est. Maritza, 600 m, Iado O Vol. Orosi, Prov. Guanacaste, 27 Feb 1992, M. I. Ortiz, L N., 1 ♂ (INBIO 326900 373000 #1505).

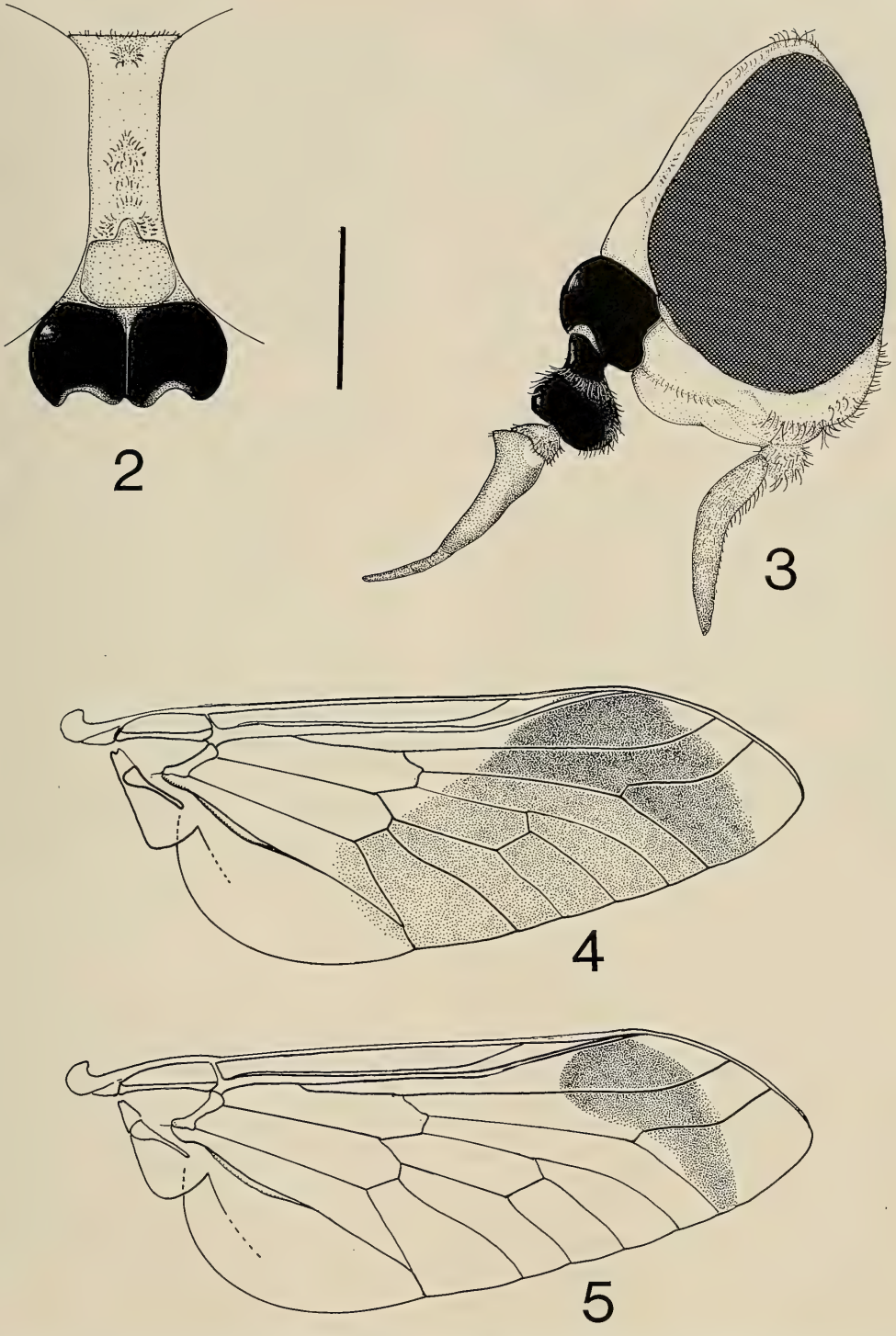
Variation in Females of *B. galindoi*

Wilkerson (1979) compared 2 females, 1 each from Panama and Colombia, with the holotype female. The specimen from Panama had lighter areas of the body paler yellow or orange-yellow, yellowish brown and dark brown maxillary palpi, and 2 brown, yellow-orange haired sublateral stripes on the abdominal tergites. The female from Colombia had the frontal callus yellowish brown, maxillary palpi wholly yellow-orange haired, mesoscutum entirely orange, with only scattered black hairs in place of a distinct dark stripe, and a diffuse yellow-orange middorsal stripe dorsally on the abdomen.

Five females of *B. galindoi* from Costa Rica were examined and compared with the holotype and the females examined by Wilkerson. Locality data for the specimens are as follows: COSTA RICA: Guan. [acaste], 3 km SE R. Naranjo, July 1992, F. D. Parker, 1 ♀ (FSCA); 14 km S. Cañas, 5–10 Sep[tember] 1990, F. D. Parker, 1 ♀ (FSCA); Her.[édia Province], La Selva Res. Sta., 11–17 Jun[e] 1986, Nadeer Youssef, 1 ♀ (FSCA); Alejuela Prov., Rio Peñas Blancas, May 1993, Frank J. Joyce, 1 ♀ (INBIO); Puntarenas Prov., Monteverde, Peñas Blancas, 5 May 1993, Frank J. Joyce, 1 ♀ (INBIO).

Four of the above specimens represent a dark form of *B. galindoi.* The specimen from Monteverde (Fig. 1) has an abdominal pattern intermediate between the wholly black abdomen of the other 4 specimens from Costa Rica and the holotype female from Panama that has the abdominal tergites orange with broad sublateral black stripes. The most conspicuous differences in the Costa Rica specimens are the wholly black apical palpomere and femora, the more intensely blackened posterior area of the wing (Fig. 4) that is nearly as intense as the jet black subapical wing patch anterior to vein R_{4+5}, and the wholly black abdomen.

There is some intraspecific variation in the Costa Rica specimens, but all are darker than the specimens from Panama and Colombia. Body length is 12–14 mm, frons usually orange-brown tomentose, but may be slightly darkened, basal callus orange to reddish brown, apical palpomere of maxillary palpi entirely black with black setae to black with extreme base yellowish, scutellum mostly black with only lateral margins orange, but more extensively orange with



Figs. 2–5. Head and wing of *Bolbodimyia galindoi*. 2, Front and subcallus of female. 3, Lateral view of female head showing antennae and maxillary palpi. 4, Wing of female. 5, Wing of male. Scale bar = 1.0 mm.

dark spot reduced in the female from Monteverde, legs entirely black with black hair to black with basal halves of fore and hind coxae orange with orange hair and extreme bases of femora orange-yellow.

The abdominal markings and hair patterns are variable. Most commonly the entire abdomen is black with patches of orange hair medianly on the tergites 1–2 and covering sternites 2–3. Orange hairs also may be present on the lateral margins of tergites 1–2 or 1–3. The female from La Selva has the lateral margins of tergites 1–2 orange with orange hair and sternites 1–2 reddish with sublateral dusky spots. The abdominal pattern of the female from Monteverde (Fig. 1) is intermediate between the dark Costa Rica specimens and the holotype female from Panama, having orange color and hairs on tergites 1–2 and the anterior ¼ of tergite 3 medianly and laterally, tergite 2 with sublateral black stripes, sternites 1–2 and the base of sternite 3 orange with orange hair, and sternite 2 with a dark median spot.

Wilkerson (1979) commented on the variability of *B. galindoi* and suggested that either more than 1 species was involved or that *B. galindoi* was single variable species. Initially, I was inclined to consider the dark Costa Rica specimens to be a distinct species, but because the males collected from Costa Rica generally agree with Fairchild's description of *B. galindoi,* except for the evanescent mesoscutal stripe, absence of infuscation posteriorly on the wing membrane, and the darker legs, and because a female from Costa Rica has an abdominal pattern intermediate between that of Fairchild's specimen from Panama and the wholly black abdomen of the other females from Costa Rica, I now consider the darker specimens to be only a variant of *B. galindoi,* pending study of additional specimens.

Key to Species of *Bolbodimyia*

1. Mesoscutum entirely orange or orange with a broad black median stripe; wings broadly orange-yellow basally, with a large diagonal dark marking (♀) or black subapical wing patch (♂) [Costa Rica to Panama] . . . . . ***galindoi*** Fairchild (♀, ♂)
– Mesoscutum not entirely orange or marked as above, usually black except for notopleural lobes or prealar lobes; wings not orange-yellow basally, dark wing markings not as above 2
2. Thorax and abdomen entirely dark brown or black, or thorax at most with tufts of pale yellow hairs on prealar lobes 3
– At least some orange or yellow on thorax or abdomen (may be evanescent in *brunneipennis*) 6
3. Hyaline apex of wing small, confined to cell R_4, not entering cell R_3; genae chocolate brown [Colombia, Ecuador, Peru] . . . . . ***nigra*** Stone (♀)
– Hyaline apex of wing more extensive, extending to vein R_{2+3} into cell R_1; genae shining black or orange 4
4. Head and legs entirely black; tarsi concolorous with tibiae [Arizona, New Mexico, Mexico] . . . . . ***atrata*** (Hine) (♀, ♂)
– Frontoclypeus and genae orange; at least mid and hind basitarsis pale 5
5. Frons black; wings darkened anteriorly, subhyaline posterior to anterior edge of cell br and veins R_3 and R_5 [Mexico] . . . . . ***bermudezi*** Tidwell & Philip (♀)
– Frons orange; wings usually more extensively darkened posteriorly [Costa Rica, Panama, Colombia] . . . . . ***erythrocephala*** (Bigot) (♀)
6. Coxae and maxillary palpi partly to mostly orange 7
– Coxae and maxillary palpi black or dark brown 8
7. Frons and subcallus shining black-brown to black; maxillary palpi with some infuscation on distal half; femora black-brown except at extreme base [Venezuela, Colombia, Bolivia] . . . . . ***bicolor*** Bigot (♀)
– Frons usually orange, rarely reddish brown to dark brown (♀); subcallus entirely orange, or orange to light brown medianly; maxillary palpi entirely orange; fore femur at least half orange basally, mid and hind femora mostly orange [Guatemala, El Salvador, Costa Rica, Panama, Colombia, Ecuador] . . . . . ***philipi*** Stone (♀, ♂)
8. Abdomen entirely black 9
– Abdomen partly or entirely orange, at least with narrow pale midventral stripe 10
9. Entire wing darkened except for hyaline apex; hyaline apex not extending to vein R_{2+3}; genae opaque brown with some orange tomentum

and hairs ventrally [Colombia, e. Peru] . . . . . ***celeroides*** Stone (♀)

– Darkened area of wing restricted to area anterior to cell br and vein R_{4+5}, otherwise subhyaline; hyaline apex of wing starting at apex of vein R_{2+3}; genae shining black, without orange hairs [Mexico, Guatemala] . . . . . ***dampfi*** Philip (♀)

10. Abdomen entirely orange, black-haired dorsally, orange-haired ventrally [Mexico] . . . . . ***lampros*** Philip & Floyd (♂)

– Abdomen with orange on venter, sometimes limited to lateral stripes or a median stripe or both 11

11. Frons of female and center of subcallus of male orange; abdomen orange along lateral margins of sternites, mostly black medianly [Argentina, Bolivia] . . . ***lateralis*** Kröber (♀, ♂)

– Frons of female at least dark reddish brown to black; abdomen ventrally either entirely orange or dark with a more or less evident median orange stripe 12

12. Abdomen entirely orange ventrally; flagellum of antenna dark brown; length 15 mm [Bolivia, e. Peru] . . . . . ***desecta*** Enderlein (♀)

– Abdomen black ventrally with a narrow, sometimes rather obscure median yellow-orange stripe, and often some orange near base laterally; flagellum of antenna mostly yellow-orange to yellow-brown; length 10–12 mm [Brazil, Guyana] . . . . . ***brunneipennis*** Stone (♀, ♂)

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I wish to thank Dr. Gary Steck, Florida State Collection of Arthropods, Division of Plant Industry, Gainesville, Florida, for his generous hospitality during my work in the collection and for the loan of specimens.

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DESCRIPTION OF THREE NEW *TRICHOGRAMMA* (HYMENOPTERA: TRICHOGRAMMATIDAE) FROM NEW ZEALAND AND THEIR RELATIONSHIP TO NEW WORLD SPECIES

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Abstract.—Three new species of *Trichogramma* are described from New Zealand: ***T. maori, T. valentinei*** and ***T. falx***. These species are the only known representatives of the cosmopolitan nominate subgenus known to occur in New Zealand. This assemblage represents a monophyletic group with closest relationship to New World species of the Drepanophorum Group. A key separating the three New Zealand species is included.

Key Words: Trichogrammatidae, *Trichogramma,* New Zealand

A recent examination of a collection of undetermined New Zealand *Trichogramma* has revealed three undescribed species. All are members of the nominate subgenus, and represent a group of remarkably distinct forms with closest ties to certain New World species. These descriptions represent the first *Trichogramma* known only from New Zealand. Noyes and Valentine (1989), in their review of New Zealand Trichogrammatidae, noted the presence of the Australian species, *T. funiculatum* Carver of the subgenus *Trichogrammanza,* and several "undetermined, mostly probably undescribed species." The descriptions below are based on a collection of card mounted specimens received from the New Zealand Arthropod Collection in Auckland which included the material examined by Noyes and Valentine. The majority of this material was collected by sweeping and Malaise trapping in relatively natural areas. Representatives of both sexes from all series were mounted in Canada balsam on slides.

The terminology associated with the male genitalia and used in the descriptions below was reviewed by Pinto (1992). Complete terms with acronyms are incorporated into the first description; their first mention is indicated in bold. The other descriptions employ the acronyms only. Important terms also are indicated in Figures 5–15. The apical distance (AD) and basal distance (BD) associated with the genital capsule require some explanation. AD refers to the distance from the apex of the parameres to the base of the intervolsellar process. BD is the distance from the base of the intervolsellar process to the base of the genital capsule. Both measures are often presented as a proportion of the total length of the genital capsule (GL). The intervolsellar process, volsellae and dorsal lamina extend within the apical distance and their length is reported in relation to it. Terminology associated with the forewings follows Doutt and Viggiani (1968) (see their Fig. 1). The number of setae between the 4th and 5th tracks on the forewing provides a relative measure of setal density. The 4th is the first setal track posterior to the RS_2; the 5th is the track immediately anterior to the r-m.

All New Zealand localities are followed by a 2-letter code referring to arbitrarily derived geographic areas as given in Crosby

Figs. 1–2. Male antenna, *Trichogramma valentinei.* 1, (230x). 2, Apex of flagellum (lateral view, 610x); arrows showing the pronounced separation of the two placoid sensilla (left arrow at apex of basal placoid sensillum, right arrow at base of apical placoid sensillum).

et al. (1976). Abbreviated collecting methods in the records section include SP (= sweeping) and MT (= Malaise trap).

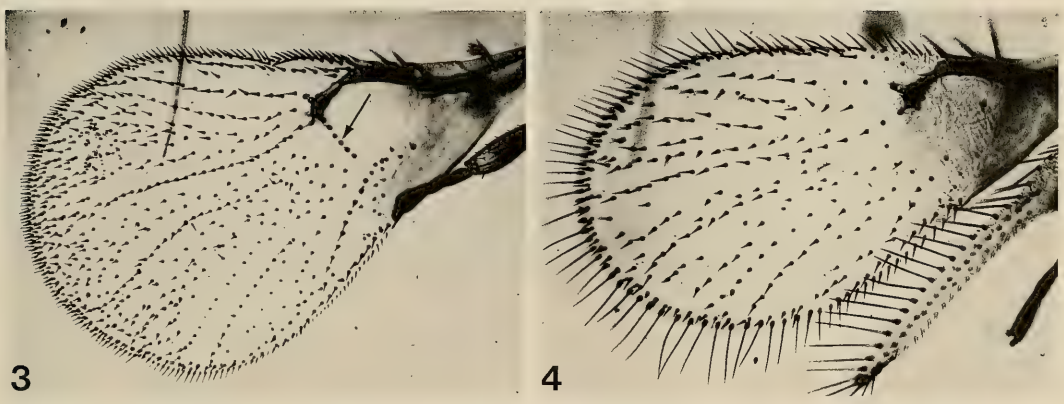
Trichogramma maori Pinto and Oatman, New Species

(Figs. 3, 5–8, 16)

Diagnosis. *Trichogramma maori* resembles the other two species described here as well as several other, primarily North American, species as follows: dorsal lamina of male genital capsule with posterior extension enlarged, concealing parameres and volsellae in dorsal view; parameres ventromedial to volsellae; volsellae strongly curved; dorsal ridge well developed. It is separated from these species by its broad forewings (ca. 0.4 mm wide), the very short fringe setae on the forewings (length <0.10 maximum wing width), the spiniform, bifid intervolsellar process, and the broad and apically subrhomboidal aedeagus (see Fig. 6).

Description. Based on slide and card-mounted material. Quantitative data reported as means ± S.D. or as ranges, taken from 3 males (hind tibial length [**HTL**] = 0.25 mm) and 3 females (HTL = 0.25–0.26 mm).

Color dark brown except head dusky yellow brown above and legs considerably lighter. Relatively large and robust, length



Figs. 3–4. Forewings. 3, *Trichogramma maori,* arrow pointing to RS_1 setal track. 4, *T. valentinei.*

(from slide-mounted specimens) 0.7–0.8 mm.

Forewing (Fig. 3) very broad, 0.42 ± 0.01 mm wide, 0.57 ± 0.01 as wide as long, setal tracks distinct, with 50–70 setae between 4th and 5th tracks; RS_1 well indicated, consisting of ca. 6 distinct setae; longest fringe setae at posterolateral corner of wing very short, their length less than 0.10 maximum wing width. Hind wing relatively broad with anterior and posterior tracks complete, both approaching apex of wing, usually with 1–2 setae between middle and posterior tracks near middle of wing. Anterior scutellar setae elongate, 0.6–0.8 length of posterior pair.

Male. Antenna (as in Fig. 1) with flagellum relatively short for body size, ca. 0.18 mm, 5.1 ± 0.03 as long as basal width (**FL/BFW**), 0.72 ± 0.01 as long as hind tibia (**FL/HTL**), 1.52 ± 0.03 length of scape (**FL/SL**); setae on flagellum relatively short, ratio of the length of the longest setae to the basal width of the flagellum (**FSL/BFW**) = 1.77 ± 0.17 (1.7–2.0); basiconic peg sensilla (**BCPS**) relatively small, subglobose apically, formula 1-1-1-0-1-1; several short, unsocketed setae scattered on ventral surface.

Genital capsule (**GC**) (Figs. 5–8) relatively broad with posterior extension of the dorsal lamina (**DLA**) broad and elongate, concealing intervolsellar process (**IVP**), volsellae (**VS**) and parameres (**PM**) in dorsal view; base of VS distinctly lateral to PM. Ratio of genital width to length (**GW/GL**) = 0.46 ± 0.02, distinctly narrower in posterior half; ratio of the apical distance to genital length (**AD/GL**) = 0.29 ± 0.01; length of the dorsal aperature (**DAL**) ca. 0.7 GL; DLA arising slightly posterior of middle of GC, its length ca. 0.4 GL; posterior extension of DLA distinctly constricted at base, sides convergent apically, posterior margin broadly rounded, extending beyond apex of PM, occupying ca. 1.3 AD; PM relatively narrow, convergent from base to apical ⅔, then slightly divergent to apex, relatively blunt apically; VS distinctly broader than PM in ventral view, strongly curved: curved anteriorly from base, then extending posteroventrally with apex attaining ca. 0.7 AD, medial surface sparsely hispid, spine of VS directed ventrally; IVP bispinose (Fig. 7), attaining ca. 0.3 AD; ventral processes (**VP**) not obvious, very small, on base of IVP; ventral ridge (**VR**) distinct, narrow, extending from IVP to ca. 0.5 basal distance (**BD**); dorsal ridge (**DR**) moderately well developed, extending from base to at least middle of GC. Aedeagus unique, apical half subrhomboidal and distinctly curved ventrally (Figs. 6, 8); relatively short but very broad; greatest width ca. 0.8 maximum width of DLA; aedeagus length (**AL**) = 0.9 GL, 0.71 ± 0.03 HTL; apodemes convergent anteriorly, their length at least 0.5 AL (posterior limits not easily discerned with light microscope).

Female.—Antenna with 1 BCPS at apex of first and second funicular segment; ovipositor relatively short, ratio of ovipositor length to hind tibial length (**OL/HTL**) = 0.70 ± 0.02.

Types: Holotype male. NEW ZEALAND. Banks Peninsula (MC), Prices Valley; x-1980; "Malaise trap, edge of native bush"; R. Macfarlane. Allotype female. Same data as holotype except collected xi-1980; both deposited in the New Zealand Arthropod Collection (NZAC); Auckland, New Zealand. Three male and 2 female paratypes (same data as holotype) deposited in NZAC and UC Riverside.

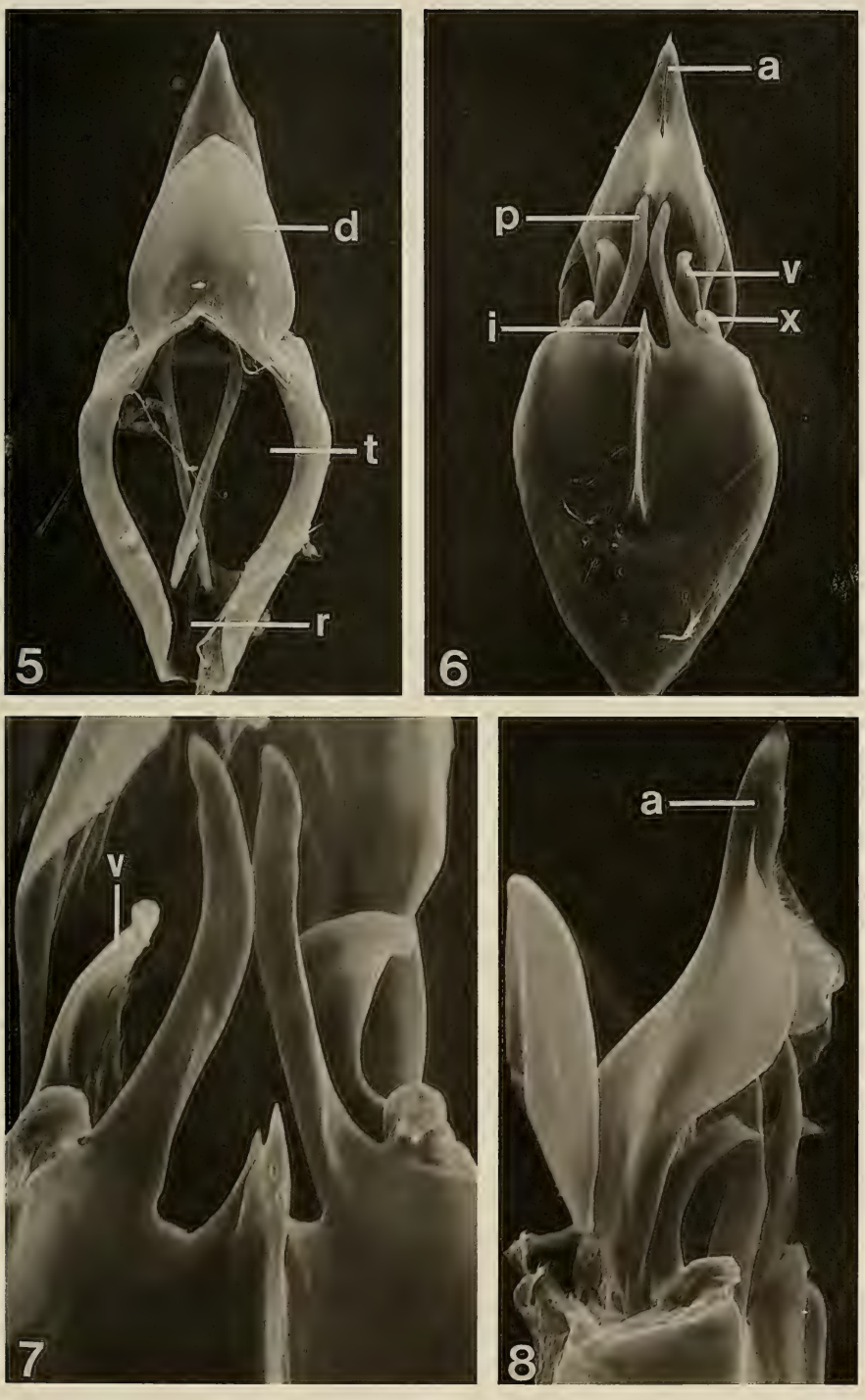
Etymology: Named for the Maori, the native people of New Zealand.

Hosts: This species has been reared from eggs of *Eutorna* sp. (Oecophoridae) and *Graphania* sp. (Noctuidae).

Geographic distribution. Fig. 16. New Zealand: North and South islands.

Material examined. 57 males and females on slides and on cards or in capsules (air dried).

Records. **New Zealand.** Auckland (AK); "*Eutorna* eggs on boysenberry"; 19 females. Banks Peninsula (Prices Valley) (MC); x-80; MT "edge of native bush"; 7



Figs. 5–8. *Trichogramma maori,* male genitalia (posterior end at top). 5, Dorsal view (408x). 6, Ventral view (460x). 7, Ventral view with 30 deg. tilt showing bispinose nature of the intervolsellar process, and hispid volsellae (1530x). 8, Lateral view showing ventral curvature of aedeagus (800x). a = aedeagus, d = dorsal lamina, i = intervolsellar process, p = paramere, r = dorsal ridge, t = dorsal aperature, v = volsella, x = base of volsella.

males, 5 females; R. Macfarlane. Birkenhead (AK); i-81; MT "in second growth bush"; 2 males; J. Longworth. Bullock Creek (WD); ii-26/iii-1-93; MT "edge *Nothofagus* forest"; 1 male; L. LeSage. Bullock Creek (WD); ii-26-93; SP "vegtn. edge of forest"; 5 females; L. LeSage. Cobb Reservoir (NN); xii-80; MT; 1 male; A. Curtis. Kinloch S(tate) F(orest), Dart R(iver) (OL); i-81; SP "*Nothofagus* for., broadleaf, grass, *P. totara*"; 1 female; J. Noyes/E. Valentine. Kongahu (NN); i-81; MT "nr swamp"; 1 female; J. Jones. Lake Rotoiti (BR); ii-⅘-78; MT; 2 males, 3 females; S./J. Peck. Makarora West (S of Nat. Pk.) (OL); i-18-81; SP *Nothofagus* forest; 1 male, 1 female; J. Noyes/E. Valentine. Lynfield (AK); xii-80; 1 male; G. Kuschel. Pigeon Hill (WD); ii-24-93; "beating broadleafed podocarp forest"; 1 female; L. LeSage. Pleasant Flat (WD); iii-6-93; SP "weeds & trees on rd"; 1 male; L. LeSage. Roaring Meg (CO); i-13-81; SP "tussock grasses, *Discaria, Rosa, Juncus, Pimela*"; 1 male; J. Noyes/E. Valentine. Te Puke (BP); xi-7-87; ex. *Graphania* eggs; 1 male, 2 females; P. Stevens. Wainui Inlet (NN); ii-23-93; SP fls. *Daucus carotta*; 1 female; L. LeSage.

Notes: Several of the records above are based on females only. Although it is not possible to determine most species of *Trichogramma* with females, those of *T. maori* can be distinguished by the combination of color, body size, fore and hindwing features and the length of the mesoscutellar setae.

Trichogramma valentinei Pinto and Oatman, New Species

(Figs. 1, 2, 4, 9–11, 17)

Diagnosis.—Distinguished from *T. maori* by its considerably narrower forewings, the absence of the RS_1 setal track of the forewing in most specimens, its more strongly curved parameres and volsellae, the much narrower, subfiliform volsellae, the larger and somewhat clavate intervolsellar process, the much greater apical distance, and the narrower aedeagus. This species is very similar to *T. falx,* described below. It is separated by two traits associated with the flagellum of the male: the considerably shorter setae, and the size and position of the basal linear placoid sensilla. Also, the mesoscutellar setae are longer in *T. valentinei.*

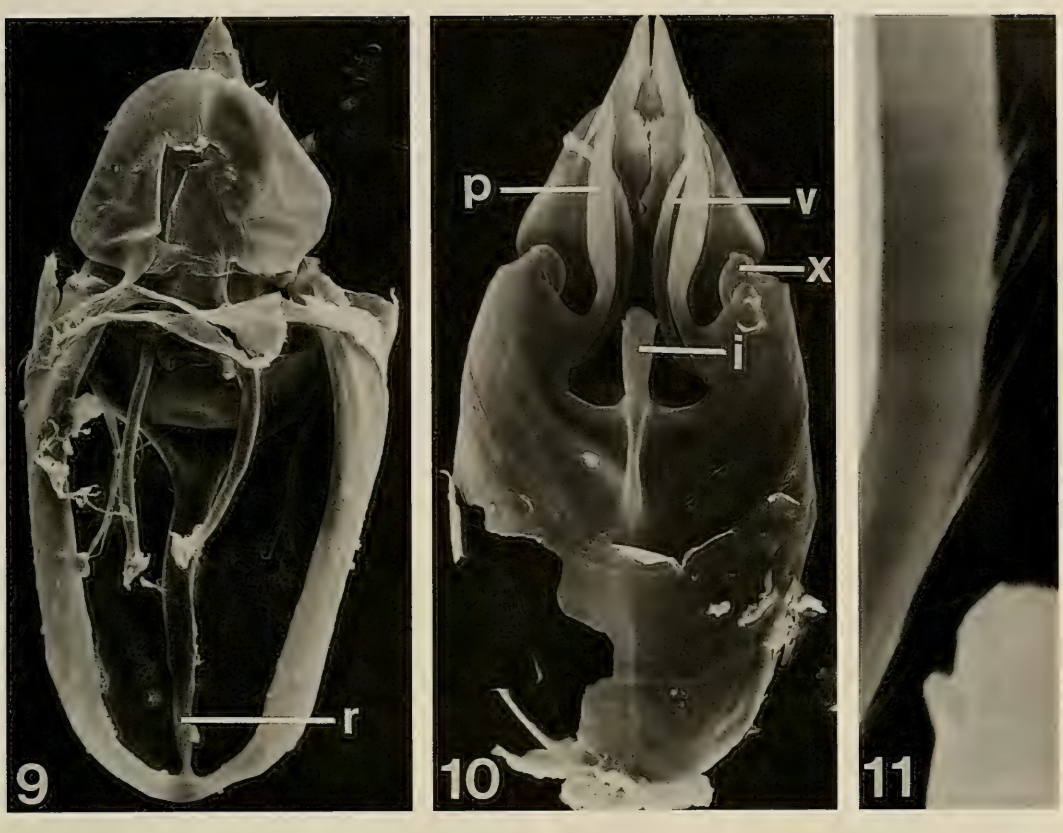
Description.—Based on 4 males and 5 females. Quantitative data taken from 2 males and 2 females (HTL = 0.20 mm for all specimens) and reported as a range unless invariant.

Color brown except head dark yellow above; relatively slender, elongate, length (from slide-mounted material) 0.7–0.8 mm.

Forewing (Fig. 4) relatively slender, 0.30–0.31 mm wide, 0.45–0.48 as wide as long, with 32–45 setae between 4th and 5th tracks; RS_1 usually absent; longest fringe setae at posterolateral corner of wing moderately long, their length 0.18–0.19 maximum wing width. Hind wing with anterior and posterior tracks short, each consisting of 4–5 setae which do not extend beyond half the distance from hamuli to wing apex. Anterior scutellar setae moderately long, 0.4–0.5 length of posterior pair.

Male.—Antenna (Fig. 1) with flagellum straight, relatively short and robust, ca. 0.16 mm long, 5.0–5.1 as long as wide, 0.79–0.81 as long as hind tibia, 1.7–1.8 scape length; flagellar setae short, robust, tapering abruptly at apex; FSL/BFW = 1.4–1.5; BCPS short, digitiform, formula 1-0-0-0-1-1; without unsocketed setae on ventral surface. Basal-most placoid sensillum relatively short, length ca. 1.2 BFW, its apical third extending above antennal surface, broadly separated from apical placoid sensillum on same (lateral) surface by a distance equal to ca. ⅔ its own length (Fig. 2).

Genital capsule (Figs. 9, 10) with DLA broad and elongate, concealing IVP, VS, and PM in dorsal view; insertion of VS distinctly lateral to PM. GW/GL = 0.42–0.46; apical distance very large, AD/GL = 0.44–0.47; DAL = 0.70 GL; DLA arising in posterior half of GC, its length ca. 0.4 GL; pos-



Figs. 9–11. *Trichogramma valentinei,* male genitalia (posterior end at top). 9, Dorsal view (630x). 10, Ventral view (570x). 11, Detail of left volsella showing hispid medial surface (4200x). i = intervolsellar process, p = paramere, r = dorsal ridge, v = volsella, x = base of volsella.

terior extension of DLA strongly constricted at base, extending beyond PM, occupying 1.1 AD; PM produced medially at base, then abruptly curving posteriorly, width increasing to middle from base, gradually tapering to apex; VS extremely elongate, narrow, subfiliform and curved, scythe shaped, attaining 0.9 AD, narrower than PM throughout entire length, curving strongly anteriorly from base, then broadly arcing posteriorly with at least medial surface hispid (Fig. 11), spine not distinct; the two VS converging at middle and diverging strongly apically; IVP inserted considerably anterior to base of PM and VS, sticklike in shape, subclavate, occupying ca. 0.4 AD; VP small, slightly protuberant, positioned near apex of IVP (Figs. 10, 11); VR poorly developed, occupying ca. 0.3 BD (not easily seen with light microscope); DR very well developed, apparently extending entire BD, bifurcating just anterior to intervolsellar bridge area with an arm extending anterolaterally to base of each VS (Fig. 9). Aedeagus relatively short, its length 0.56–0.57 HTL and 0.73–0.76 GL; moderately broad, ca. 0.5 maximum width of posterior extension of DLA, subconical apically, tapering noticably to a distinct point; apodemes comprising ca. 0.4 AL.

Female.—Antenna with funicular segments subquadrate; BCPS at apex of F1, absent from F2. Ovipositor 0.69–0.75 HTL.

Types: Holotype male. NEW ZEALAND. Cobb Ridge (Sth) (NN), 1100 m; xii-3-1980; "native tussock grassland"; J. Noyes/E. Valentine/A. Walker. Allotype female. Data as for holotype. Types deposited

in NZAC. Three male and 2 female paratypes with same data as holotype in NZAC and UC Riverside.

Etymology: Named after the New Zealand entomologist, Dr. E. W. Valentine.

Variation: A short RS_1 setal track, consisting of 3 setae, is present in one specimen from the type locality.

Geographic distribution. Fig. 17. New Zealand: known from a single locale on South Island.

Material examined: 10 males and females on slides and on cards (air dried).

Records: **New Zealand.** Cobb Ridge (NN) (see type information); 5 males, 5 females.

Trichogramma falx Pinto and Oatman, New Species
(Fig. 17)

Diagnosis.—This species is very closely related to *Trichogramma valentinei.* It is separated by differences in male antennal features, and length of the mesoscutellar setae (see below).

Description.—Based on 5 males and 1 female. Quantitative data taken from 3 males (HTL = 0.15–0.17 mm) and 1 female (HTL = 0.17 mm), and represented by means ± S.D. or ranges.

As in *T. valentinei* except as follows: Anterior mesoscutellar setae shorter, minute, no more than 0.1 the length of posterior pair. *Male.* Antenna with flagellum with longer, less robust setae, FSL/BFW = 2.38 ± 0.2 (2.2–2.6); basal placoid sensillum longer, its length ca. 1.6 BFW, with, at most, apical $^1/_5$ of sensillum extending above antennal surface, its apex attaining base of apical placoid sensillum on same (lateral) surface; with a few short unsocketed setae on ventral surface of basal half of flagellum.

Other descriptive features as follows: Color brown; body length ca. 0.6 mm. Forewing relatively narrow, 0.23–0.26 mm wide, FWW/FWL = 0.45 ± 0.01, with 24–26 setae between 4th and 5th tracks. RS_1 absent. Hind wing with 1–6 setae in both anterior and posterior tracks. *Male.* Antenna: FL/BFW = 5.02 ± 0.26; FL/SL = 1.73 ± 0.08; FL/HTL = 0.93 ± 0.01. Genital capsule: GW/GL = 0.47 ± 0.04; AD/GL = 0.47 ± 0.03; DLA occupying 1.1 AD; VS and IVP attaining ca. 0.9 and 0.4 AD, respectively. Aedeagus length 0.61 ± 0.02 HTL, 0.80 GL. *Female.* Ovipositor length 0.85 HTL.

Types: Holotype male. NEW ZEALAND. St. Arnaud (BR), 600 m; xii-9-1980; "native grassland/sphagnum bog"; J. Noyes/E. Valentine/A. Walker; deposited in NZAC. Three male paratypes, same data as type, deposited in NZAC and UC Riverside.

Etymology: Falx: Latin for sickle; in reference to the shape of the volsellae in this species.

Geographic distribution: Fig. 17. New Zealand: South Island.

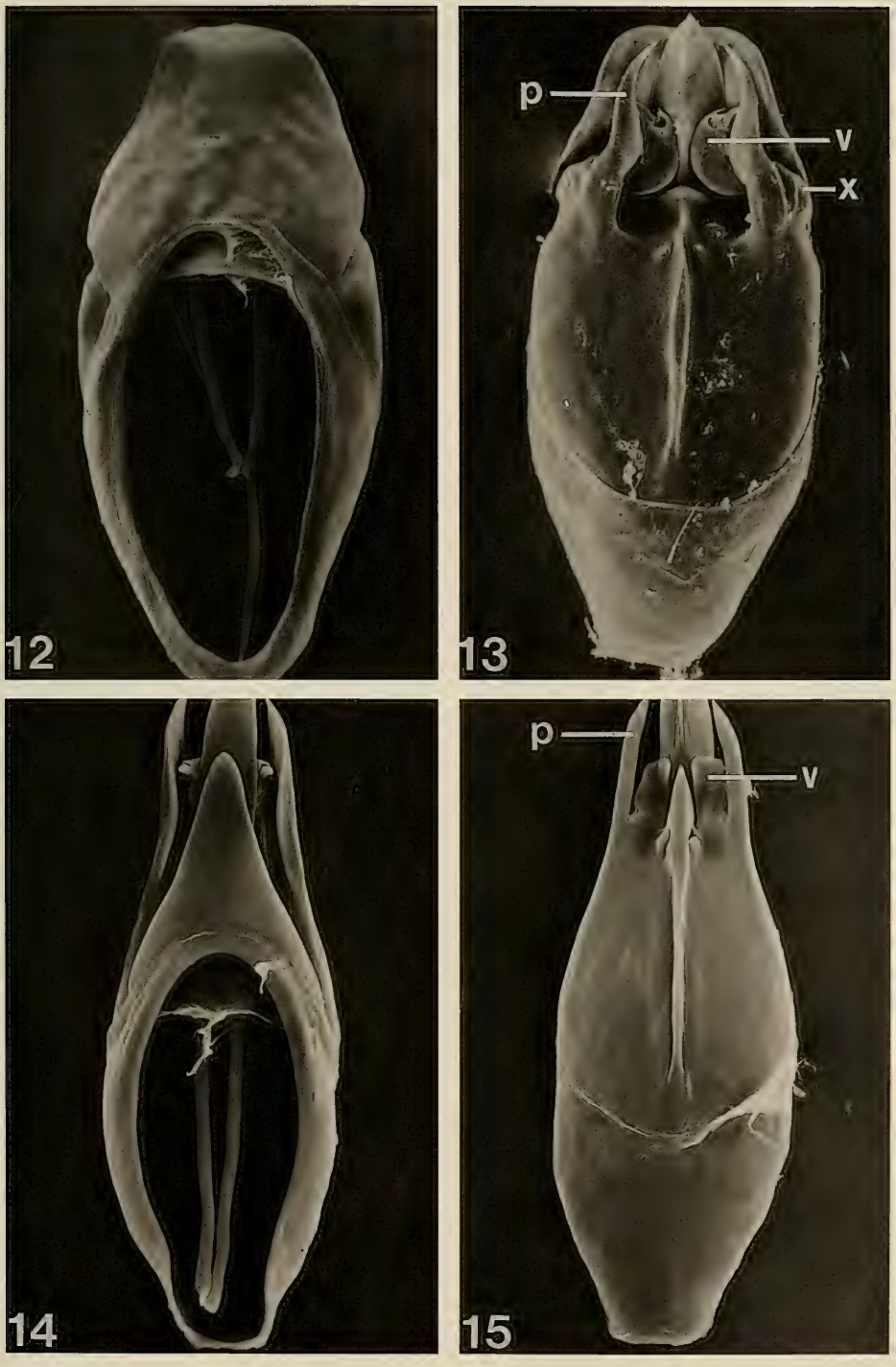
Material examined: Six males and females, all on slides.

Records: **New Zealand.** Cromwell Beetle Res., Cemetary Rd (CO); xi-17-77; "litter"; 1 male, 1 female; J. Watt. St. Arnaud (BR), see type information; 4 males.

Notes: The absence of the RS_1 setal track is unique to *T. valentinei* and *T. falx.* The presence of this line of setae is one of the characters commonly used to distinguish *Trichogramma* from *Trichogrammatoidea* (Pinto and Stouthamer 1994). It's absence in these species is almost certainly a reversal considering the presence of all other wing and genitalic features defining *Trichogramma,* intraspecific variation of this trait in *T. valentinei,* as well as the derived nature of the genitalia in both species. The antennal differences separating *T. falx* from *T. valentinei* are consistent with species differences separating other closely related *Trichogramma,* such as *T. minutum* and *T. exiguum* in North America (Pinto et al. 1983).

Discussion

The three new *Trichogramma* appear to represent a monophyletic assemblage of



Figs. 12–15. *Trichogramma* genitalia (posterior end at top). 12–13, North American *T.* sp. a of *Drepanophorum* Group: 12, Dorsal (770x). 13, Ventral (700x). 14–15. *T. semblidis:* 14, Dorsal (700x). 15, Ventral (640x). p = paramere, v = volsella, x = base of volsella.

Figs. 16–17. Distribution of *Trichogramma* spp. in New Zealand. 16, *T. maori.* 17, *T. valentinei* (triangle); *T. falx* (dots).

species. Their closest ties are to the Drepanophorum Group of North America to which they are tentatively assigned. This group includes *T. drepanophorum,* described by Pinto & Oatman (1985), and at least two undescribed species (= *T.* sp. a, *T.* sp. b). All occur in the eastern United States; the male genitalia of *T.* sp. a are shown in Figs. 12, 13. This species group is characterized by the following derived traits: 1) posterior extension of the dorsal lamina greatly enlarged and concealing parameres and volsellae dorsally; 2) floor of dorsal aperture with a well-defined dorsal ridge, 3) base of parameres medial to that of volsellae, 4) volsellae strongly curved. The plesiomorphic condition for these features, found in most *Trichogramma,* can be illustrated by the Holarctic species *T. semblidis* (Figs 14, 15) where the posterior extension is considerably narrower and linguiform, the dorsal ridge is absent, the parameres are lateral to the volsellae, and the volsellae are straight or only slightly curved. Interestingly, a bifid intervolsellar process as in *T. maori* (Fig. 7) also occurs in *T.* sp. b of the Drepanophorum Group.

The limits of the Drepanophorum Group are currently being investigated as part of a revision of North American *Trichogramma* (Pinto, in prep.), and several additional forms possessing one or more of its defining features may ultimately be assigned. The geographic distance of North American members of the group from those in New Zealand may be an artifact of sampling considering the virtual absence of collections from South America especially in the southern, temperate regions of the continent.

The monophyly of the New Zealand species is not immediately obvious. In fact *T. maori* is not noticeably more similar to its New Zealand congeners than to the North American *T.* sp. a. The phenetic distance is roughly similar in both directions. The structure of the volsellae, however, suggests that the three New Zealand species do represent a monophyletic assemblage. In all three species the volsellae curve anteriorly

from their base and the medial surface is hispid. These traits are not known to occur in any other species of *Trichogramma.*

The three species described here are the only known New Zealand representatives of the speciose subgenus *Trichogramma.* Although four species of this cosmopolitan group were introduced to the country from other parts of the world for biological control, these apparently have not become established (Cameron and Allan 1989), and none occurred in the collection examined for this study. The neighboring Australian *Trichogramma* fauna is represented by several species of the nominate subgenus as well as three species of the subgenus *Trichogrammanza* (Oatman and Pinto 1987). Australian representatives of the former group reflect Asian affinities however (Pinto and Stouthamer 1994) and none has yet been recorded from New Zealand. The Drepanophorum Group is not known to occur in Australia. *Trichogrammanza,* on the other hand, is restricted to Australia and New Zealand, and the same or very similar species occur in both countries. Thus, the known *Trichogramma* of New Zealand include only four named species: *T. maori, T. valentinei, T. falx,* and *T.* (*Trichogrammanza*) *funiculatum.* The nominate species are related to a New World element; the *Trichogrammanza* are closely tied to Australia.

It should be mentioned that Noyes and Valentine (1989) estimated at least 15 undetermined species of New Zealand *Trichogramma* in addition to *T. funiculatum.* This estimate was based on a collection of card mounted specimens that we also examined for this study. Separation of *Trichogramma* to species is virtually impossible unless specimens are mounted on slides, and Noyes and Valentine appear to have overestimated the diversity of their collection. This material includes no more than eight species: the three described above, one or, at most, two very similar *Trichogrammanza* (including *T. funiculatum*), and two or three additional new species closely related to *T. valentinei* and *T. falx.* Unfortunately, the latter are represented by limited material that cannot adequately be described at this time. Included here are two specimens of a wingless form taken on Auckland Island at 150°, 32′ S latitude, a collection representing the southernmost record for the genus.

Key to the New Zealand Species of the Drepanophorum Group of *Trichogramma*

1. Male genitalia as in Figs. 5, 6 with intervolsellar process (IVP) spinelike; IVP originating at approximately same level as parameres. Forewing (Fig. 3) broad, with a distinct RS_1 setal track and a short setal fringe, length of longest setae in fringe less than 0.1 maximum wing length . . . . . *T. maori*

1′. Male genitalia as in Figs. 9, 10, with intervolsellar process (IVP) subclavate; IVP originating distinctly anterior to parameres. Forewing (Fig. 4) much narrower, usually without a distinct RS_1 setal track and with a much longer setal fringe, length of longest setae in fringe 0.15–0.20 maximum wing length 2

2. Male flagellum (Fig. 1) with setae short and robust, the length of longest setae ca. 1.5 basal width of flagellum; lateral surface with basal-most placoid sensillum widely separated from apical placoid sensillum (Fig. 2) . . . *T. valentinei*

2′. Male flagellum with longer, more slender setae, the length of longest setae at least twice the basal width of flagellum; lateral surface with basal-most placoid sensillum attaining base of apical placoid sensillum . . . . . *T. falx*

Acknowledgments

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A NEW SPECIES OF *SIRTHENEA* SPINOLA (HETEROPTERA: REDUVIIDAE) FROM KOREA

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Abstract.—***Sirthenea koreana,*** new species, is described from Korea. It is similar to *S. dimidiata* Horváth but differs by the yellow head and numerous yellow areas on the ventral side of the abdomen.

Key Words: Heteroptera, Reduviidae, *Sirthenea,* Korea

Three species of the genus *Sirthenea* Spinola were known from the East Palearctic (Cai and Lu 1990). *Sirthenea flavipes* (Stål 1855) is distributed in nearly the whole Oriental Region, South China (to 37° N) and Japan (Honshu, Kyushu, Shikoku). It was recorded also from Korea (Central, South, Chejudo - Okamoto 1924; Maruda 1929; Lee and Kwon 1991; etc.), but it is evident that records from Central and partly from South Korea were based on the new species described below. *Sirthenea dimidiata* Horváth, 1911 is distributed in South China (to 30° N) and in Taiwan (type locality). *Sirthenea melanota* Cai and Lu, 1990 is described from one male collected in the Shaanxi Prov. of China. Comparison with specimens of *S. flavipes* and descriptions of two other species shows that most Korean specimens belong to an undescribed species.

Following abbreviations are used for collections in Korea, in which the type material of the new species is kept (curators are indicated in parentheses): ASI—Department of Entomology, Agricultural Sciences Institute, Rural Development Administration, Suwon (Dr. S.B. Ahn); CL—collection of Prof. C.E. Lee, Taegu; CNU—Department of Agricultural Biology, Chungnam National University, Taejon (Prof. K.R. Choe); EWUB—Department of Biology, Ewha Womans University, Seoul (Prof. B.J. Rho); EWUM—Natural History Museum, same University (Prof. I.R. Lee); GNU—Department of Biology, Gyeongsang National University (Prof. J.S. Park); KPNU—Department of Agricultural Biology, Kyungpook National University, Taegu (Prof. Y.J. Kwon); SNUS—College of Agriculture and Life Sciences, Seoul National University, Suwon (Prof. K.S. Woo); TU—Department of Biology, Taejon University, Taejon (Prof. S.H. Nam).

Sirthenea koreana Lee and Kerzhner, New Species
(Figs. 1–7)

Description.—*Color.* Head yellow, with brown to black subtriangular spot in ocellar area usually subdivided partly or completely by light median stripe; in darkest specimens, this spot prolonged back to hind margin of head, in females sometimes absent; lateral parts usually with more or less distinct oblique brownish stripe from base of rostrum to lower border of eye and then to hind margin of head; in darkest specimens,

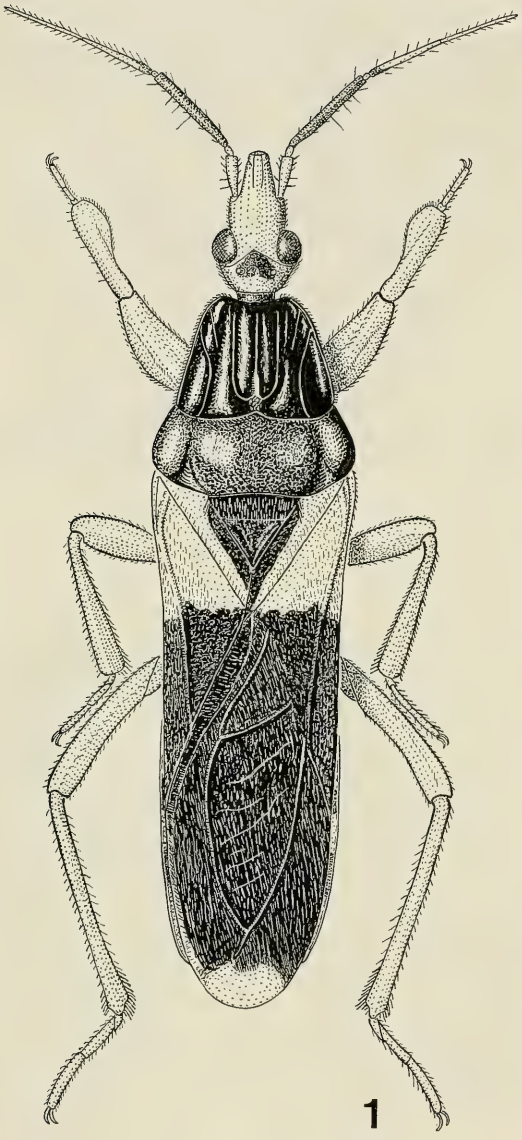


Fig. 1. *Sirthenea koreana,* male paratype.

also with brown spot behind eye. Antenna yellow; segment II and base of segment III brown, but intercalar segments yellow. Rostrum yellow. Fore lobe of pronotum black; hind lobe brown to black. Scutellum black. Hemelytra yellow at base; inner half of clavus and all corium behind apex of clavus dark brown to black. Membrane black with whitish apical spot. Legs yellow, without embrowned areas. Ventral side of thorax dark brown to black, propleurae behind suture paler, acetabulae yellow. Abdomen beneath dark brown to black, segment II, median part of segment III, anterior half of connexival segments III–VI, connexival segment VII, and genital segments in both sexes yellow.

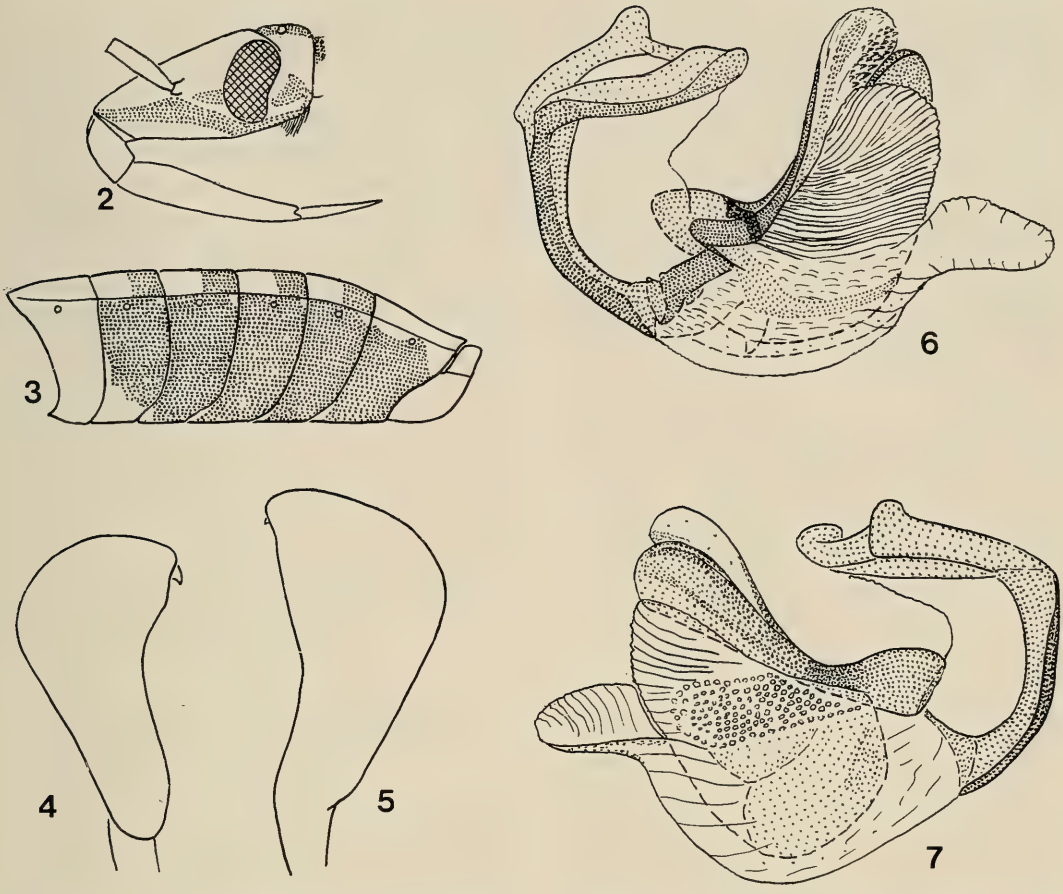
Structure: Head porrect; anteocular part much longer than postocular one. Antennal segment I reaching or slightly surpassing apex of head, segment II distinctly longer than III and IV. Rostral segment II not surpassing hind margin of head. Fore lobe of pronotum with distinct median and lateral furrows. Hemelytra in male nearly reaching to slightly surpassing apex of abdomen, in female reaching middle to hind margin of abdominal segment VI. Fossa spongiosa of fore legs 0.4 times as long as fore tibia. Exterior margin of metepisterna with 2 parallel, equally developed carinae.

Male genitalia as figured (Figs. 4–7).

Measurements (in mm, females in parentheses): length 19–22 (23–24), width at pronotum 4.5–5.1 (4.5–4.8), at abdomen 4.1–4.6 (4.5–4.8), head length 3.4–3.8 (4.2–4.5), anteocular part 2.0–2.2 (2.5–2.6), postocular part 0.55–0.60 (0.7–0.8), head width 2.1–2.3 (2.3–2.5), interocular distance 1.0–1.1 (1.25–1.30), interocellar distance 0.55–0.60 (0.60–0.65), length of antennal segments (I–IV) 1.1–1.2 (1.2–1.3), 2.45–2.90 (2.2–2.4), 2.0–2.3 (1.8–1.9), 2.1–2.2 (2.0), length of rostral segments (I–III) 0.9–1.0 (1.1–1.2), 2.5–2.9 (3.5–3.7), 1.5–1.6 (1.6–1.7), length of fore pronotal lobe 2.9–3.2 (3.4–3.7), of hind pronotal lobe 1.8–2.0 (1.6–1.8), of scutellum 1.8–2.0 (1.8–2.0), of hemelytra 12.2–13.7 (11.2–12.1).

Variation.—In both specimens from Daedeong, the exterior vein of clavus is brown and basal part of corium exterior to vein *Cu* light brown, so that only a longitudinal stripe on clavus and the interobasal part of corium remain yellow. Also legs, especially hind tibiae, are darkened in these specimens. No other differences are found.

Nymph (IV instar).—Head, rostrum and antennal segment I yellow; antennal seg-



Figs. 2–7. *Sirthenea koreana.* 2, Head, lateral view. 3, Abdomen, lateral view. 4, Right paramere. 5, Left paramere. 6,7, Aedeagus in two positions.

ments II and III, except their intercalar segments, brown (segment IV missing). Thorax and wing pads black. Legs yellow, hind femora in distal half (except apex) and hind tibiae (except both ends) brownish black. Abdomen yellow, more or less reddish dorsally and lateroventrally; round spots around openings of scent glands on segments III–V, square spots in postero-exterior corners of segments IV–VII, and segments VIII–IX black. Measurements (in mm): head length 3.4, width 1.95, antennal segments length I 1.0, II 1.6–1.8, III 1.5, pronotum length 3.2, width 3.3–3.4, body length 17–19.

Holotype: Male, KOREA, KYONGSANGPUKTO, mountains S of Taegu, 24.VI.1970, C.E. Lee (CL).

Paratypes (all from Korea).—KYONGGIDO: Anseong, 30.V.1983, P.C. Hi, 1 male (EWUM); Enjeongbu, 3.VI.1966, B.J. Rho, 1 male (EWUB); Pokwangsa, 20.IV.1981, B.J. Rho, 1 male (EWUB); Kwacheon, 28.V.1972, B.J. Rho, 1 male (EWUB); Kuanak Mts, 15.V.1965, B.J. Rho, 1 male (EWUB); Kwangneung, 28.V.1973, S.M. Lee, 2 males (KPNU); Mt. Wangbang, 7.VI.1974, S.M. Lee, 1 male (KPNU); Suweon, 28.V.1987, C.J.Y., 1 male (SNUS); Suweon, 3.VI.1987, Y.H. Ko, 3 males (SNUS); Suweon, 10.VI.1985, D.S. Yang, 1 male (SNUS); Suweon, 10.VI.1987, S.J.H., 1 male (SNUS); Suweon, 21.VI. 1985, S.B. Ahn, 1 female (ASI); Suweon, 8.VII.1974, K.K. Choi, 1 male (ASI); Suigen (= Suweon), 1.III.1925, T. Hanaya, 1

male (ASI); Sugien (= Suweon), 22.VI.1926, Yugato, 1 male (ASI); Suweon, 15.VI.1968 and 25.V.1969, D.S. Lee, 2 males (ASI); Suweon, 1. and 16.VI.1987, S.H. Kim, 2 males (ASI); Koangleung, 10.VI.1990, K.T.J., 1 male (SNUS); Koanggyo, 22. and 30.VI.1987, J.J.H., C.S.R., H.Y.S. and K.H.G., 4 males (SNUS); Yonseuprim, 2.VI.1988, W.B.H., 1 male (SNUS); Mt. Suri, 7.VI.1968, J.C. Jeung, 1 male (SNUS); Sumokweon, 6.VI.1987, Y.K.H., 1 male (SNUS). KANGWONDO: Cheongpyoung, 31.V.1987, C.W. Lee, 1 female (SNUS); Cheungpyoung, 18.VI.1987, Y.K. Chung, 1 male (SNUS). CHOLLAPUKTO: Mt. Jirisan, 25.V.1988, B.L.O., 1 male (CNU). CHOLLANAMDO: Muan, 1–5.VI.1991, R.G.O., 1 male (ASI); Goheung, 26–27.V.1991, R.G.O., 1 male (ASI). KYONGSANGPUKTO: as holotype, 1 male (CL); Chilgok Eup, 31.V.1983, Y.J. Kwon, 2 males, 1 female (KPNU, 1 male in Zoological Institute, St. Petersburg); same locality, 21.VI.1990, Y.J. Kwon, 1 male (KPNU); Mt. Tohamsan, 30.V.1984, Y.J. Kwon, 1 male (KPNU); Kyongpook University, Taegu, 10.VI.1968, K.L. Choi, 1 male (SNUS); same locality, 5.VI.1987, K.I.J., 2 males (SNUS); same locality, 12.VI.1992, K.S.S., 1 female (SNUS); Weolseong, 6.VI.1989, L.H.M., 1 male (SNUS); Hwasan, 28.IV.1968, C.S. Kim, 1 male (SNUS); Mt. Pomun, 20.V.1989, Y.H. Cho, 1 male (CNU). KYONGSANGNAMDO: Jinyanggun, Hysongseokkyon, Sinpungri, 30–31.V.1992, E.H. Kim, 1 male (GNU); Jinyang, Socksari, 15. and 23.V.1987, J.S. Jeon and Y.S. Ryu, 2 males (GNU); Sancheonkun, Chuckdong Myeon, Boechunri, 25.V.1987, W.H. Paik, 1 male (GNU); Hamyangkun, Seohari, 31.V.1987, J.S. Park, 1 male (GNU); Hoseong, 24.V. 1987, H.G. Kang, 1 nymph (GNU); Okcheon, 20.V.1989, G.S. Kim, 1 male (CNU); Simcheon, 28.V. and 3.VI.1993, K.S.I., 2 males (CNU). CH'UNGCH'ONGPUKTO: Noeundong, 4.VI.1982, W.Y. Lee, 1 male (CNU). CH'UNGCH'ONGNAMDO: Nonsan, 5.VI.1972, S.M. Lee, 1 male (KPNU); Taejon, Yongmundon, 31.V.1988, S.M. Cha, 2 males (TU); Taejon, Yooseong, 4.VI.1987, H.D. Park, 1 male (TU); Gujeuk, 17.V.1987, H.G. Yun, 1 male (CNU); Buyou, 15.V.1988, H.J. Kim, 1 male (CNU); Yuseong, 6.VI.1981, G.S. Kim, 1 male (CNU); Yuseong, 13.V.1988, G.S. Yeem, 1 male (CNU); Chungnam University, 31.V.1990, B.J. Yeem, 1 male (CNU); Sannae, 28.V.1993, L.H.J., 1 nymph (CNU); Mt. Kyeryong, V.1989, S.L. Lee, 1 male (CNU); Mt. Kyeryong, 31.V., Y.S. Kim, 1 male (CNU); Daedeag, 12.VI.1980, K.R. Choe, 2 males (ASI); Nonsan, 10.V.1991, R.G.O., 2 males (ASI and Zoological Institute, St. Petersburg); Yaecheon, 1–5.VI.1991, R.G.O., 1 male (ASI); Cheonan, 9.VII.1991, R.G.O., 1 male (ASI); Yongweondong, 22.V.1991, T.K. Kim, 1 male (TU). Province unknown; Mt. Dapgok, 22.VI.1988, B.H. Lee, 2 males (SNUS). Without labels: 1 male (CNU).

Comparison.—The new species differs well from other Palearctic species in coloration. In *S. flavipes,* the fore lobe of pronotum, except fore margin and furrows, is yellow, head laterally with a black longitudinal stripe crossing the eye, hemelytra (both) with 3 yellow spots in the fore half, of which two are basal and the third is placed behind scutellum (f. *apicalis* Signoret) or, if the spots are united in one large spot (f. *typica*), the hind margin of this spot is with quadrangular protuberance in middle; the ventral side of abdomen is with a median yellow stripe reaching segment VII; inner carina of metathorax widely obliterated in the middle; hemelytra nearly reaching apex of abdomen in female. In *S. melanota* coloration of hemelytra is as in *S. flavipes* f. *apicalis* but basal light spots of hemelytra are much smaller, besides the fore lobe of pronotum, ventral side of head and most of abdominal segment II are black. *Sirthenea dimidiatus* is very similar to the new species in coloration of hemelytra and pronotum, but the head, rostral segment I and nearly the whole ventral side of abdomen are black, tibiae and tarsi of

middle and hind legs fuscous. The new species is intermediate between *S. dimidiatus* and *S. flavipes,* sharing coloration of pronotum and hemelytra with the first and of head and abdominal venter with the second.

The following specimens of *S. flavipes* from Korea were examined by us: Chollanamdo Prov., Pokildo I., Chunri, 21.VII. 1981, N.J. Yun, 1 female (EWUM); Kyongsangnamdo Prov., Jinyang, 26–30.VIII.1992, R.G.O., 1 male (ASI); Chejudo I., Seogwipo, 1. and 13. IX.1975, H.S. Kim. 1 male, 1 female (ASI). All of them belong to f. *apicalis.*

Acknowledgments

We are thankful to Dr. S.B. Ahn, Prof. K.R. Choe, Prof. Y.J. Kwon, Prof. I.R. Lee, Prof. S.H. Nam, Prof. J.S. Park, Prof. B.J. Rho and Prof. K.S. Woo for the opportunity to use for description specimens from collections under their curation.

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A NEW SPECIES OF *CLADIOPSOCUS* (PSOCOPTERA: CLADIOPSOCIDAE) FROM MEXICO

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Abstract.—***Cladiopsocus ocotensis,*** n. sp., from Chiapas, México, is described and illustrated. It is the second species of the genus recorded in México. Assignment to subgenus is not made because the male is unknown. It is most closely related to *C. clarus* Eertmoed, based on the clear wings lacking stubs.

Key Words: *Cladiopsocus,* new species, Cladiopsocidae, Chiapas, México

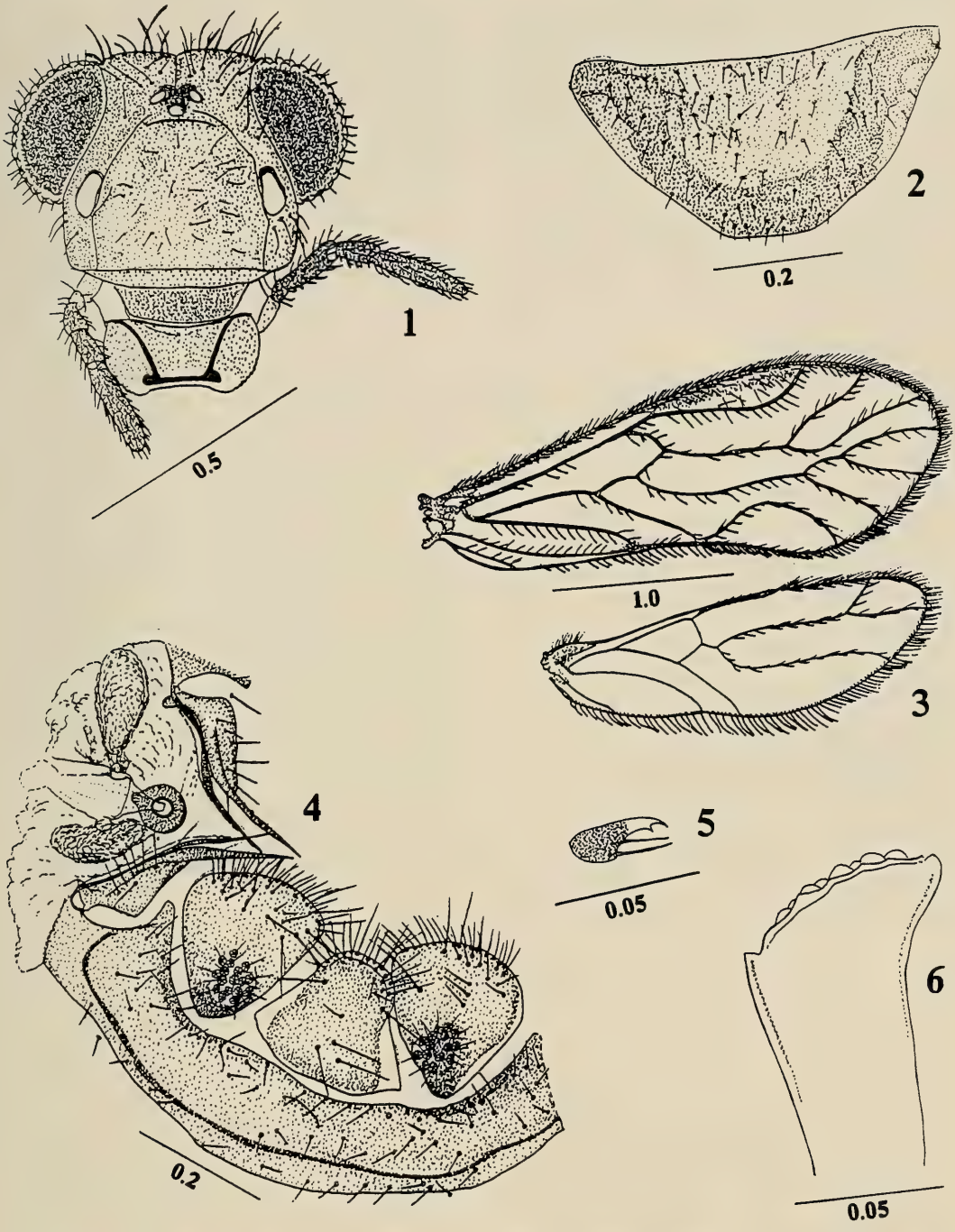
The species of *Cladiopsocus* are predominantly Neotropical, only two species having been recorded from Angola. The Neotropical species have been recorded in Brazil, Colombia, Guatemala, Panamá, Perú, and in southern México (Eertmoed 1986). The purpose of this paper is to describe a species of *Cladiopsocus* collected in Chiapas, perhaps one of the biologically richest Mexican states, in a continuing effort to document the Mexican psocid fauna. This species constitutes the second *Cladiopsocus* to be recorded in México; the other Mexican species is *C. garciai* Eertmoed (1986) from the states of Guerrero, Jalisco, and Veracruz. Unfortunately only one female specimen was available for study, and for this reason, assignment to one of the two subgenera recognized in the genus was not possible, because the distinction is made on male characters (Eertmoed 1986).

The single female holotype was dissected in 80% alcohol and its parts mounted in Euparal. Measurements were taken with a filar micrometer whose measurement unit is 1.36 microns for wings and 0.53 microns for other parts. Abbreviations for lengths of parts measured, or counted, are as follows: FW = fore wing; HW = hind wing; F = femur; T = hind tibia; t_1, t_2, t_3, = tarsomeres; ctt_1 = number of ctenidia on t_1; P_4 = fourth segment of maxillary palp; f_1 . . . f_n, = flagellomeres; IO = minimum distance between compound eyes; D = anteroposterior diameter of compound eye; d = transverse diameter of compound eye; PO = d/D. Measurements are given in microns.

Cladiopsocus ocotensis García Aldrete, New Species
(Figs. 1–6)

Color (in 80% alcohol).—Ground color pale brown. Compound eyes brown, ocelli clear, with dark brown centripetal crescents. Coxae, trochanters, and femora pale brown; tibiae and tarsi dark brown. Tergal lobes and scutella of meso- and metathorax brown. Wings hyaline, slightly fumose; veins brown. Abdomen whitish, with brown subcuticular rings.

Morphology.—Sides of labrum sinuous (Fig. 1). Areola postica wide (Fig. 3). Subgenital plate broad, setose, with a well-defined, pigmented band along sides and posterior margin (Fig. 2). Ovipositor valvulae (Fig. 4): V1 slender, sclerotized, acuminate; lateral lobe of dorsal valve (V_2 + V_3), elongate, setose. Ninth sternum rough textured,



Figs. 1–6. *Cladiopsocus ocotensis*. 1, Front view of head. 2, Subgenital plate. 3, Fore and hind wings. 4, Ovipositor valvulae, ninth sternum, paraprocts, epiproct, and clunium. 5, Pretarsal claw. 6, Lacinial tip. Scales are in mm.

with spermapore large, surrounded by a broad, strongly pigmented band, almost circular, slightly extended anteriorly (Fig. 4). Paraprocts robust, approximately triangular, with apices rounded; sensory fields with 15–17 trichobothria on basal rosettes (Fig. 4). Epiproct large, bell shaped (Fig. 4). Setae of paraprocts and epiproct as illustrated. Clunium with slender pigmented bands on posterior margin, next each paraproct, and a mesal, crescent-shaped sclerotized ridge, next epiproct (Fig. 4).

Measurements.—FW: 2921; HW: 2176; F: 652; T: 1128; t_1: 452; t_2: 62; t_3: 70; ctt_1: 23; P_4: 193; f_1: 447; f_2: 336; f_3: 272; f_4: 239; f_5: 154; f_6: 153; f_7: 123; f_8: 119; IO: 291; D: 295; d: 159; IO/D: 0.98; PO: 0.53.

Type material.—Holotype female: MEXICO, Chiapas, Biosphere Reserve "El Ocote," 50 km NW Ocozocoautla, 2nd lookout point over La Venta River, 730 m, I.V. 1993, on tree trunk in forest, A. N. García Aldrete and E. Barrera. Deposited in the Insect Collection, Department of Zoology, Instituto de Biología, UNAM, México City.

Etimology.—The specific name refers to the type locality.

Comments.—Eertmoed (1986) redefined *Cladiopsocus* utilizing 18 characters, to set it distinctly apart from *Spurostigma* and Ptiloneuridae. The species here described is assigned to *Cladiopsocus* on the basis of 11 of those characters, even though three characters of *C. ocotensis* fall outside the known variation in the genus: 1) The labral lines at the proximal margin of the labrum curve around but do not continue distad along the lateral margins; 2) R1 closing the pterostigma does not reach the wing margin at a right angle, the angle is more acute in this species; and 3) vein 2A in the fore wing is longer than usual. Since only one specimen of *C. ocotensis* is known, a statement on variation is presently unwarranted. Like *C. clarus* Eertmoed, this species has clear wings without stubs, but unlike *C. clarus,* it has the second and third tarsomeres well defined, not fused, and the spermapores in both species are different. Although some specimens of the other Mexican species (*C. garciai* Eertmoed) also lack stubs in the fore wing, the subgenital plates in both are clearly different. *Cladiopsocus ocotensis* probably belongs in the subgenus *Cladiopsocus,* Group 2, subgroup 3 in Eertmoed's classification of the family (1986), but in the absence of the male this can not be established categorically.

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98(3), 1996, pp. 415–438

LIFE HISTORIES AND DESCRIPTIONS OF ADULTS AND IMMATURE STAGES OF TWO CRYPTIC SPECIES, *ACIURINA FERRUGINEA* (DOANE) AND *A. MICHAELI,* NEW SPECIES (DIPTERA: TEPHRITIDAE), ON *CHRYSOTHAMNUS VISCIDIFLORUS* (HOOKER) NUTTALL IN SOUTHERN CALIFORNIA

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Abstract.—*Aciurina ferruginea* (Doane) and the newly described species, ***A. michaeli*** Goeden, are sympatric univoltine fruit flies that form different, distinct types of axillary bud galls on branches of high-elevation plants of *Chrysothamnus viscidiflorus* (Hooker) Nuttall in southern California. Both species heretofore were called *A. ferruginea*; however, the gall attributed to this species in the literature in actuality belongs to *A. michaeli.* Accordingly, the gall of *A. michaeli* is smooth and beaked apically; the gall of *A. ferruginea* is subspheroidal and covered by many thin, threadlike leaves, its shape apparently unlike other tephritid galls described to date. The adults of *A. michaeli* are described as having a wholly dark brown or dark reddish-brown scutellum that readily distinguishes them from *A. ferruginea* which have a yellow or reddish-yellow scutellum. The slightly sexually dimorphic, but otherwise indistinguishable, wing patterns of both species are described and illustrated. The egg, third instar, and puparium of *A. michaeli* and *A. ferruginea* are described, illustrated and compared. The first and second instars of *A. ferruginea* also are described and illustrated. The eggs of both species have long pedicels that allow respiration by embryos within egg bodies buried during oviposition in axillary buds covered by resin. The third instar of *A. michaeli* is pyriform with abdominal tergites III–VI protrudent; the third instar of *A. ferruginea* is oblong-ellipsoidal. The prothorax in *A. michaeli* lacks the verruciform sensilla that circumscribe the prothorax in *A. ferruginea* in a single row. The anterior thoracic spiracles in *A. michaeli* have three or four papillae; whereas, *A. ferruginea* have five papillae. The puparium of *A. michaeli* is pale yellow; that of *A. ferruginea* is light to reddish-yellow.

Key Words: Insecta, *Aciurina, Chrysothamnus,* biology, galls, taxonomy of adults and immature stages, parasitoids

The five *Aciurina* spp. (Diptera: Tephritidae) forming galls on *Chrysothamnus nauseosus* (Pallen) Britton and *C. viscidiflorus* (Hooker) Nuttall (Asteraceae) in southern California were studied by us to expand upon the seminal studies of Wangberg (1981) in Idaho and to clarify certain of his findings as taxonomically interpreted by Steyskal (1984). This paper follows our published life history of *A. thoracica* Curran (Headrick and Goeden 1993), as second in a projected series of life histories to include at least three more southern California species of *Aciurina.* Herein, we distinguish a heretofore little known, cryptic, congeneric species of *Aciurina* that forms galls on the same host plant as *A. ferruginea* (Doane), that Wangberg (1981) called "*Aciurina* sp. B" and Steyskal (1984) suggested was *A. idahoensis* Steyskal. The bi-

ology and gall of *A. ferruginea* are redescribed and the immature stages and adults of this species and the new species are comparatively described.

Materials and Methods

Most field studies were conducted on *Chrysothamnus viscidiflorus* (Hooker) Nuttall (Asteraceae) South of Wongo Peak, along Horseshoe Meadow Road at Little Cottonwood Creek at 2810-m elevation, Inyo Nat. Forest, Inyo Co., in the southern Sierra Nevada Mountains. Samples of branches from individual plants that bore galls of *A. ferruginea* (as interpreted in the present paper) during previous years and contained overwintering eggs and larvae were collected on 14.viii.1993 and 18.ix.1993. Galls containing larvae and puparia of *A. ferruginea* were sampled from the same plants and others at this location during April–July, 1991–94. Additional collections of mature galls were made SE of Long Valley at 1730 m, in Kennedy Meadows at 1830 m, SE of Kennedy Meadows in Big Pine Valley, and S of Rattlesnake Meadow at 2160 m during July, 1991 and 1992. All four sites are located in the Sequoia Nat. Forest (N section) in Tulare Co. Galls of the new species described herein as *A. michaeli* were principally collected under the mistaken belief that they belonged to *A. ferruginea* as studied and its galls and biology described by Tauber and Tauber (1967) and Wangberg (1981). Branch samples bearing eggs and galls were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Twelve and 14 ova dissected from mature females, 25 and five larvae, eight and two puparia of *A. ferruginea* and the new species of *Aciurina,* respectively, dissected from galls were preserved in 70% EtOH for scanning electron microscopy (SEM). All other fully grown larvae and puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM later were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24 h, dehydrated through an increasing series of acidulated EtOH, critically point dried, mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screened-top cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cagings were used for longevity studies and oviposition tests in the insectary of the Department of Entomology, University of California, Riverside, at 25 ± 1°C, and 14/10 (L/D) photoperiod. Virgin male and female flies obtained from emergence vials as well as field-swept adults were paired in clear-plastic petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey (Headrick and Goeden 1991) for direct observations, videorecording, and still-photography of their courtship and copulation behavior to be reported elsewhere (Headrick and Goeden, unpublished data).

Plant names used in this paper follow Munz (1974); tephritid names follow Foote et al. (1993). Descriptions of the adults use the nomenclature of Foote et al. (1993); modified elements of the formats of Steyskal (1984), Hernández O. (1993), and Goeden (1993); and only flies individually reared from galls. Nomenclature used to describe the immature stages follows Goeden and Headrick (1990; 1991a, b; 1992), Headrick and Goeden (1990, 1991, 1993), and the telegraphic format of Goeden et al. (1993, 1994a, b). Means ± SE are used throughout this paper. The holotype, allotype, and four individually reared paratypes of each sex of the new species, *A. michaeli,*

have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). Two additional, individually reared paratypes of each sex also were deposited in the collection of the California Academy of Sciences (CAS). One male and two female paratypes reared by J. A. Wangberg were deposited in the W. F. Barr Entomological Museum (WFBARR), University of Idaho, Moscow, along with other material on loan viewed, confirmed, and identified during the present study. Seven remaining female paratypes and voucher specimens of swept adults of *A. michaeli* not designated as paratypes and its parasitoids reside in the research collections of RDG; preserved specimens of larvae and puparia are stored in a separate collection of immature Tephritidae maintained by JAT. Two each, individually reared males and females of *A. ferruginea* used for comparison with *A. michaeli* were also deposited in the USNM and CAS collections, and in the James Entomological Collection at Washington State University, Pullman (WSUP) in gratitude for the loan of the holotype of the former species.

Results and Discussion

Taxonomy

Adult.—The new species described below is very similar to *Aciurina ferruginea* in appearance, and probably resides under this name in most collections, as it did with RDG until comparison was made of specimens reared from two different morphs of galls collected together from high-elevation demes of *Chrysothamnus viscidiflorus* in the southern Sierra Nevada Mountains. The new species with a mostly dark brown scutellum is readily distinguished from *A. ferruginea* which has a yellow or reddish-yellow scutellum. This is the main morphological difference between the adults of these two cryptic species, otherwise distinguished by their distinctive galls. Accordingly, the following key to replace couplet 8 in the key to North American species of *Aciurina* in Foote et al. (1993) [couplet 15 (16) in Steyskal (1984)] enables one to distinguish these closely related species (parenthesized additions and deletions are those of RDG):

8. Cell r_{4+5} wholly brown or with small rounded hyaline spot near wing tip adjacent to vein M; cell c broadly hyaline distally, with transverse median brown bar . . .; cell dm with preapical hyaline spot (usually) not extending to veins at sides of cell (but sometimes barely touching vein R_{4+5} anteriorly) 8a

8a. Scutellum entirely dark brown or occasionally dark reddish brown with yellow or reddish yellow apex . . . . . ***michaeli* Goeden n. sp.**

– Scutellum all yellow, reddish-yellow, or broadly so along entire posterior margin . . . . . ***ferruginea* (Doane)**
Cell r_{4+5} with preapical hyaline mark occupying at least half of width of cell. . . ,

– sometimes with an additional subbasal hyaline mark . . . ; cell c with distal dark area . . . or its apex sometimes largely hyaline 9

Aciurina michaeli Goeden, New Species

Aciurina ferruginea: Tauber and Tauber 1967: 907 (reproductive behavior, biology, gall photo). Wangberg 1981: 712–714 (gall description, biology, parasitoids).

Male (Holotype).—*Head:* Light to golden yellow; occiput dark brown and covered with fine grey pollinosity. Three pairs of frontal bristles; two pairs of orbital bristles; inner vertical bristles and ocellar bristles well developed and light brown; other bristles wholly or basally white or light yellow.

Thorax: Dark brown, mesonotum covered with fine grey pollinosity and many prominent, pale to golden yellow setulae posteriorad as far as and including all but shiny, posterior margin of dark brown scutellum. Mediotergite dark brown, shiny medially, grey pollinose dorsally and laterally. All of the following bristles are present and brown: One pair of postpronotals; scapular bristles indistinguishable from microtrichia or absent; one pair of postsutural dorsocentrals slightly posteriorad of presutural supra-alars, at one-fourth the distance to the supra-alar bristles; two pairs of notopleurals; one pair each of post-alars, intra-alars,

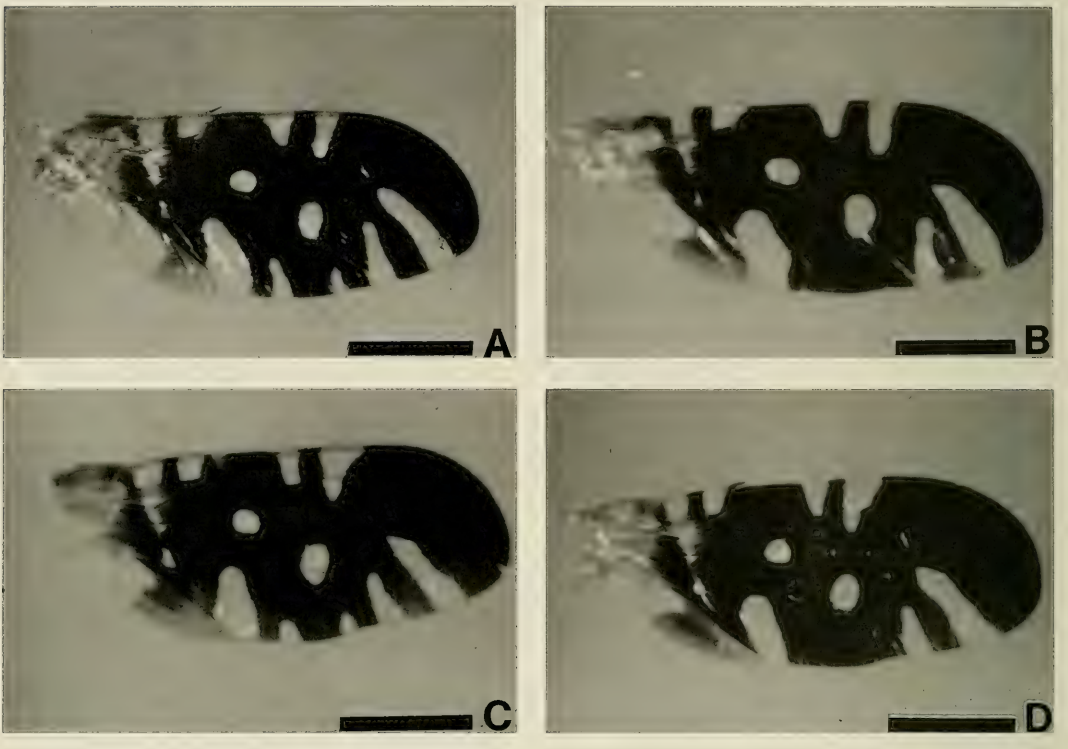

Fig. 1. Excised right wings of *Aciurina michaeli* (A) male, (B) female; and *A. ferruginea* (C) male, (D) female. Bar = 1 mm.

and acrostichals; scutellum with one pair of basal, prominent, scutellar bristles; katepisternal bristles well developed. Coxae, femora, tibiae, and tarsi yellow; fore femora twice as thick as mid- and hind femora and bearing loose "comb" of long, anteroventral setae. Wings (Fig. 1A) mostly dark brown with marginal hyaline incisions and internal marks as follows: cell bc wholly hyaline; cell c broadly hyaline distally, with transverse median brown bar; cell r_1 with two triangular, hyaline spots along costa, the proximal spot extending to vein R_{2+3}, the distal spot to vein R_{4+5}; cell r_{4+5} wholly brown with a distinct bulla; cell dm with preapical hyaline spot not extending to vein CuA_1, but in right wing, not left wing, just touching vein M; cell m with median hyaline, wedge-shaped stripe reaching vein M and sub-basal, wedge-shaped spot two-thirds as long; cell br with prominent, round or oval, preapical spot; cell cua_1 with three marginal incisions, apical incision short and hugging vein CuA_1, central narrow incision not reaching CuA_1; and prominent basal incision starting at vein $A_1 + CuA_2$ extending anteriorly to or nearly to CuA_1.

Abdomen: Shiny, dark brown, variously marked with reddish-brown dorsoanteriorly; pleura yellow, dark brown ventrally, epandrium black; tergum sparsely covered with fine, light or dark microtrichia.

Female (Allotype).—*Head:* Like ♂. *Thorax:* Like ♂, but mediotergite black. Coxae, femora, tibiae, and tarsi reddish-yellow; fore femora unthickened. Wings like ♂, but dimorphic, as cell cua_1 usually with only one marginal, hyaline incision (Fig. 1B). Abdomen with oviscape shiny black, funnel-shaped, stout.

Variation. Heads of some ♂ paratypes are fuscous, with reddish-brown or light brown bristles; posterior orbital bristles sometimes lighter, shorter, and thicker than

anterior pair. Thorax lengths of 7 ♂ averaged 1.39 ± 0.033 (range, 1.30–1.52) mm. Microtrichia, like thorax, sometimes fuscous and reaching posteriorly only to base of scutellum; scutellum of ♂ paratype from Idaho reddish-brown with yellow brown apex. Mediotergite sometimes black; coxae, femora, tibiae, and tarsi sometimes fuscous. The distal hyaline spot arising on costa of 2 ♂ paratypes does not reach vein R_{4+5}; the preapical hyaline spot in cell dm not touching vein M in all ♂ paratypes (Fig. 1A). Sub-basal hyaline spot in cell m, keyhole-shaped instead of wedge-shaped in 2 ♂ paratypes. Central narrow hyaline incision in cell m rarely absent. Abdomen also wholly dark brown or black dorsally and yellow, reddish-yellow, or partly black ventrally.

Coloration of ♀ paratypes as holotype and ♂ paratypes, except scutellum of 1 ♀ from California with reddish-yellow apex; 2 ♀ from Idaho with reddish-yellow scutellum, including apex, but reddish-brown laterally on posterior margin. Proximal hyaline spot extending only halfway across cell r_1 and distal spot across only anterior fourth of same cell in 1 small ♀ paratype; central incision in cell cua_1 represented by small, hyaline, premarginal spot in 4 ♀ paratypes. Thorax lengths of 14 ♀ averaged 1.66 ± 0.05 (range, 1.10–2.00) mm; oviscapes averaged 0.304 ± 0.007 (range, 0.275–0.369; n = 13) times as long as rest of abdomen. Tergite (T)1 black, T2 black anteriorly or T2 to T6 reddish-brown, or T6 with pair of black spots or nearly all black.

Diagnosis: The main morphological character separating the adults of *A. michaeli* from *A. ferruginea* is the color of the scutellum as described above. Both species are distinguished from other North American species of *Aciurina* by having cell r_{4+5} wholly brown, or according to Foote et al. (1993), this cell may sometimes bear a small rounded hyaline spot near wing tip adjacent to vein M (but see discussion below).

Types: Holotype, male, Middle Canyon, 2690 m, E of Boundary Peak in the White Mountains (just E of CA border), Inyo Nat. Forest, Esmeralda Co. Nevada; 10.vi.1987; R. D. Goeden, coll.; reared from gall on *C. viscidiflorus* mounted with fly (USNM); allotype, female, same data as holotype (USNM). Paratypes: NEVADA: 3 ♂ and 7 ♀; same data as holotype (3 ♂ and 4 ♀ to USNM, 2 ♀ to CAS). IDAHO: 1 ♂ and 2 ♀; 15 mi SW Rogerson, Twin Falls Co.; 25.vii.1975; J. K. Wangberg (717-34); re. from galls on *C. viscidiflorus* (galls mounted with specimens) (WFBARR). Also individually reared by R.D.G. and J.A.T. from galls on *C. viscidiflorus* in CALIFORNIA: 2 ♂ and 2 ♀; Rodeo Flat, 2200 m, Sequoia Nat. Forest, Tulare Co.; 14.vi.1990 (2 ♂ to CAS). 1 ♂ and 3 ♀; S of Wongo Peak at Little Cottonwood Creek on Horseshoe Meadow Road, 2810 m, Inyo Nat. Forest, Inyo Co.; 23.vi.1992 (1 ♂ to USNM). 1 ♀; Big Pine Meadow, along Kennedy Meadow Road, Tulare Co.; 14.vi.1993 (remaining 7 ♀ paratypes held in research collection of RDG).

Additional swept specimens examined and reared specimens mounted without galls examined and not designated as paratypes, included from CALIFORNIA: 1 ♂; Mahogany Creek, Sequoia Nat. Forest (N section), Tulare Co.; 25.vii.1984. 9 ♂ and 3 ♀ at 3140 m and 3 ♂ and 1 ♀ at 3440 m on White Mountain, Inyo Nat. Forest, Inyo Co.; 19.ix.1987. 10 ♂ and 4 ♀; above and W of Wyman Canyon at 3020 m on White Mountain, Inyo Co., Inyo Nat. Forest; 27.vii.1989. 1 ♀; N of Mono Lake, 1990 m, Mono Co.; 31.vii.1992. 1 ♂; Mormon Meadow along Clearwater Creek and road to Bowie, 3050 m, Mono Co.; 31.vii.1992. 8 ♂; S of Wongo Peak at Little Cottonwood Creek on Horseshoe Meadow Road, 2685 m, Inyo Co.; 31.vii.1992. 9 ♂ and 5 ♀; S of Wongo Peak at Little Cottonwood Creek on Horseshoe Meadow Road, 2810 m; 17.viii.1994. IDAHO: 1 ♂; 7 mi NW of Weston, Franklin Co.; 3.viii.1958; A. L. Gittens, coll. 7 ♂ and 1 ♀; 10 mi S of Gilmore, Lemhi Co.;

24.vii.1959; H. C. Manis, coll. 2 ♀; 2 mi SW of Rogerson, Twin Falls Co.; 28.vii.1965. 1 ♀; 19 mi W of Swan Valley, Bonneville Co.; 19.vii.1966; L. S. Hawkins, coll. 2 ♂; 2 mi W of Carey, Blaine Co.; 29.vi.1974; L. S. Hawkins, coll. 1 ♂ and 2 ♀; 12.5 mi SE Oakley, Cassia Co.; 17.vii.1975; J. K. Wangberg (706-34); re. from galls on *C. viscidiflorus*. 4 ♂ and 1 (probable) ♀ (abdomen missing); 7 mi NE Craters of the Moon Nat. Mon., Butte Co.; 23.vii.1975; J. K. Wangberg (715-34); re. from galls on *C. viscidiflorus*. 3 ♂ and 4 ♀; 20 mi SW Rogerson, Twin Falls Co.; 13.vii.1978; J. K. Wangberg (698-34); re. from *C. nauseosus*. OREGON: 1 ♀; Redmond; 6.viii.1939; Schuh & Scott, coll. 1 ♂; Klamath Falls; 13.viii.1954; Toby Schuh, coll. 4 ♂; 2.5 mi E Sheaville, Malheur Co.; 24.vii.1966 (2 ♂) and 13.vii.1966 (2 ♂); E. J. Allen, coll. 2 ♂; Riggins, Idaho Co.; 31.vii.1967. WASHINGTON: 1 ♂ and 1 ♀; 2 mi. E. Washucha, 1000 ft. Adams Co.; 24.viii.1976; W. Turner, coll.; *Chrysothamnus*. 1 ♀; Hanford Site, ALE. radio telescope N46°23.549′W119°35.125′, Benton Co.; 12.ix.1994; R. S. Zack, coll. 2 ♂; Hanford site, ALE. radio telescope, N46°23.549′W119°35.125′, Benton Co.; 18.viii.1994; R. S. Zack, coll. 1 ♂; Hanford Site, ALE. Rattlesnake Ridge, spring, N46°24.391′W119°36.312′, Benton Co.; 19.viii.1994.

Etymology: Aciurina michaeli is named for my son, Michael, who along with his mother, my wife Joan (Goeden 1993), and his two sisters (for whom my next two new species will be named), are continuing sources of pride in their accomplishments and the principal foci of my non-entomological life.

Discussion: Aciurina michaeli does not belong to the *Aplopappi* group, i.e. *A. mexicana* (Aczél), *A. mixteca* Hernandez O. (1993), *A. thoracica* Curran, and *A. aplopappi* (Coquillett), designated by Steyskal (1984), and adopted by Foote et al. (1993) and added to by Hernandez O. (1993). Examination of the holotype of *A. ferruginea* confirmed that this specimen, which lacks an abdomen, right middle leg, and both hind legs, and from which the right wing was removed and slide mounted (Zack 1984), nevertheless, has a yellow scutellum. Furthermore, the sex of the holotype, which Doane (1899) noted had "yellow on the posterior margin of the scutellum", but which lacked an abdomen, probably is a male, judging from the three marginal incisions present in cell cua_1 of the left wing remaining on this specimen [Plate III, Fig. 6 in Doane (1899); Zack 1984] and the slide-mounted right wing (Zack 1984).

The key character involving scutellum color so useful for separating California *A. ferruginea* from *A. michaeli* may show regional variation, as indicated by the three reared paratypes from Idaho. Also, among specimens swept from *C. viscidiflorus* in southern California 40 keyed to *A. ferruginea* and 55 to *A. michaeli* (1: 1.4); whereas, among swept or reared specimens mounted without galls in material examined from Idaho, 139 keyed to *A. ferruginea* but only 37 to *A. michaeli* (3.8:1). This predominance of *A. ferruginea* contradicts Wangberg's (1981) description of the galls of *A. michaeli* (identified by him as those of *A. ferruginea*) as being "commonly collected"; whereas, adults of *A. ferruginea* (his *Aciurina* sp. B) were ". . . rarely reared in the laboratory and not observed in the field" and the galls as ". . . collected at 3 widely separated localities" (see further discussion below on identity and descriptions of galls of these tephritids). Future examination of fly specimens from Idaho and elsewhere carefully mounted with galls from which each was individually reared, as done with specimens from southern California in the present study, may clarify this issue. That certain *Aciurina* spp. show regional differences in wing patterns will be documented in our forthcoming paper on *A. idahoensis* (Goeden and Teerink, unpublished data).

Examination of the swept specimens described above yielded none from California,

Idaho, Oregon, or Washington with a small round hyaline spot near the wing tip in cell r_{4+5} adjacent to vein M, as noted in the keys of Steyskal (1984) and Foote et al. (1993). Specimens bearing this spot probably are variants of *A. trixa* Curran, which Steyskal (1984) synonymized with *A. bigeloviae* (Cockerell), but Dodson & George (1986) resurrected [correctly so, as the two species are, indeed, morphologically and biologically distinct, and the former is the most common species on *C. nauseosus* in southern California (Headrick, Goeden, and Teerink, unpublished data)]. Doane (1899) did not mention or illustrate any such spot, nor does the holotype bear same. However, two of 41 (5%) swept males from California did have a small, subbasal hyaline spot in cell r_{4+5}. Additionally, in 17 of 41 (40%) swept specimens from California, including the preceding two males, the preapical hyaline spot in cell dm extended to and barely touched vein M, also contrary to the keys of Steyskal (1984) and Foote et al. (1993) (also see note on this character in the redescription of *A. ferruginea* below).

Differences in the immature stages and galls of *A. michaeli* and *A. ferruginea* described below further confirm the separate identities of these two species. I take this opportunity to redescribe *A. ferruginea* from a series of 21 ♂ and 14 ♀ individually reared from galls in comparison to the preceding description of *A. michaeli* to supplement the brief description which Doane (1899) based on a single damaged specimen.

Aciurina ferruginea (Doane)

Aciura ferruginea Doane 1899: 182 (holotype, male, WSUP; Pullman, Wash.).

Aciurina ferruginea (Doane): Curran, 1932: 10.

Aciurina sp. B of Wangberg 1981: 722 (gall photo), 727–728 (host plants, gall description, biology).–Steyskal 1984: 595 (revision).

Tephrella ferruginea (Doane): Bates, 1935: 109.

Head: As described above for *A. michaeli,* but generally lighter in color with golden yellow setae and bristles, or the latter brown.

Thorax: Thorax of 21 ♂ averaged 1.54 ± 0.02 (range, 1.36–1.68) mm in length; of 14 ♀, 1.8 ± 0.03 (range, 1.66–2.02) mm in length; dark brown, mesonotum covered with fine grey pollinosity and many, prominent, reddish-yellow or golden setulae posteriorad as far as and including all but posterior margin of scutellum. Scutellum pale yellow to reddish-yellow entirely, or at least along its entire posterior margin. Setae as described for *A. michaeli.* Coxae, femora, tibiae, and tarsi yellow or reddish-yellow like *A. michaeli.* Wings (Fig. 1C, D) as described for *A. michaeli,* but pattern more uniform throughout individuals examined. One reared female had a small subbasal hyaline spot in cell r_{4+5} of one wing. In three of 31 (14%) swept specimens from California, the preapical hyaline spot in cell dm extended to and barely touched vein M. Moreover, the apical incision in cell cua_1 was absent in all 14 reared ♀ and all 9 swept ♀ from California. One reared ♀ and one swept ♀ from California had a central medial incision and the former ♀ had this incision reduced to a small hyaline submarginal dot. Therefore, like *A. michaeli,* this character provides evidence of slight sexual dimorphism in wing patterns, heretofore unreported among North American *Aciurina* spp. (Steyskal 1984, Foote et al. 1993), but strongly developed in at least two additional California species currently under study (Goeden unpublished data).

Abdomen: Shiny, mostly reddish-yellow, with T5 sometimes wholly or laterally black, and epandrium always black, tergum sparsely covered with fine, light or dark microtrichia. Female with oviscape shiny black, funnel-shaped, stout, 0.345 ± 0.008 (range, 0.315–0.380; n = 7) times as long as rest of abdomen; T1 to T6 reddish-brown.

Of 31 ♂ and 8 ♀ swept specimens from California, 12 ♂ from White Mountain had

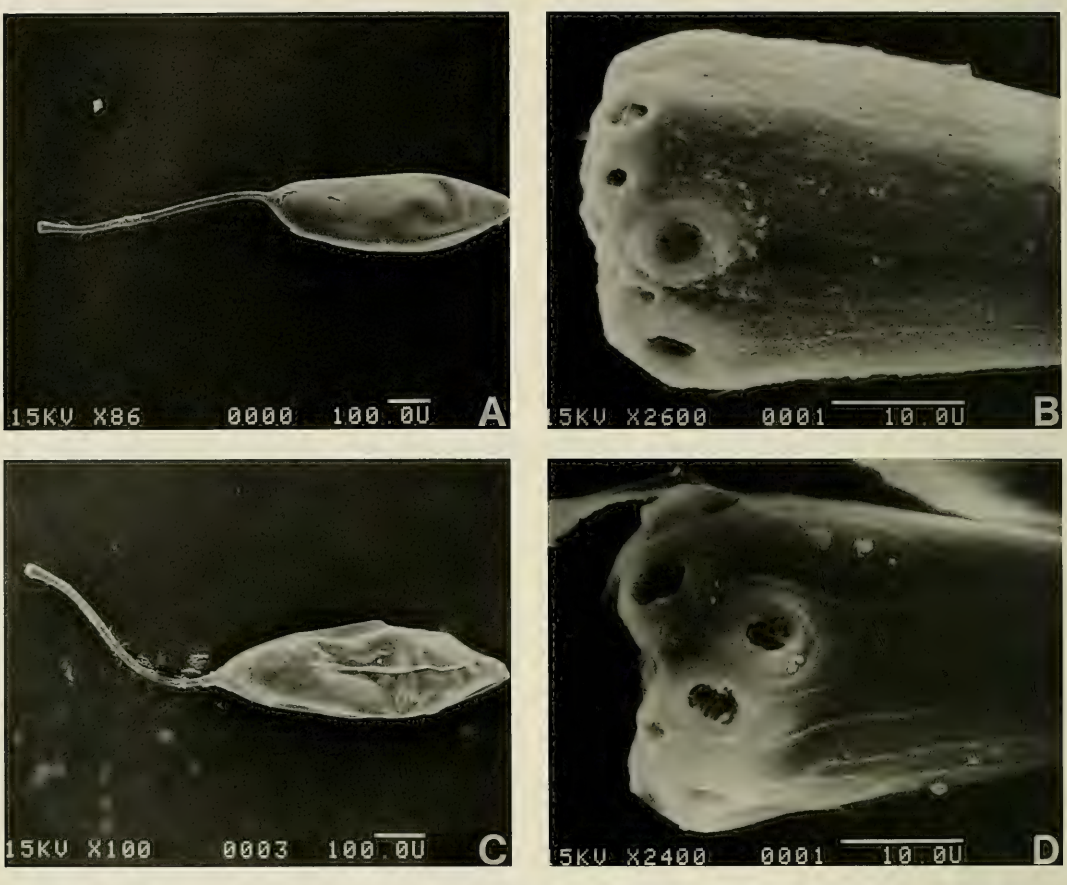

Fig. 2. Eggs of *Aciurina michaeli* and *A. ferruginea:* (A) egg of *A. michaeli,* (B) apex of pedicel of *A. michaeli* egg, (C) egg of *A. ferruginea,* (D) apex of pedicel of *A. ferruginea* egg.

all-black abdomens; whereas, 19 ♂ from the study site S of Wongo Peak had abdomens ranging from all-black to nearly all reddish-brown except for a black epandrium. Therefore, the color of the abdomens of the males of *A. ferruginea* like *A. michaeli* is quite variable. The lack of black abdomens among reared males of *A. ferruginea* from the study site S of Wongo Peak also indicates that the patterns of color on their abdomens vary within and among local fly populations. Five of six females of *A. ferruginea* swept on White Mountain had abdomens all reddish-brown except for black oviscapes and limited darkening on T1 on two, but the remaining female from the same mountain had a nearly black abdomen. The only female swept at the Wongo Peak site was as described above.

Comparisons of Immature Stages.—*Egg.* Fifteen ova of *A. michaeli* (Fig. 2A) were white, opaque, smooth; with an elongate-ellipsoidal body, 0.60 ± 0.004 (range, 0.56–0.62) mm long, 0.19 ± 0.005 (range, 0.16–0.24) mm wide, smoothly rounded at tapered posterior end; and with an elongate, anterior pedicel, 0.46 ± 0.016 (range, 0.36–0.56) mm long, 0.02 mm wide medially, and 0.04 mm wide at knoblike, anterior apex (Fig. 2B). Twenty-five ova of *A. ferruginea* with similar habitus (Fig. 2C); body 0.62 ± 0.006 (range, 0.58–0.66) mm long, 0.21 ± 0.003 (range, 0.20–0.24) mm wide; pedicels 0.59 ± 0.005 (range, 0.54–

0.62) mm long, 0.02 mm wide medially, and 0.04 mm wide apically (Fig. 2D).

These descriptions agree with the photo and description of the egg of what Tauber and Tauber (1967) reported as *A. ferruginea,* and may, indeed, refer to this species because of the mean and ranges for the lengths of the pedicel that they reported, i.e. 0.62 (range, 0.58–0.65; n = 4) mm. However, the eggs of *A. ferruginea* and *A. michaeli* differ strikingly from the short-pedicelled, partly reticulated egg of *A. thoracica* described by Headrick and Goeden (1993). As noted above, *A. thoracica* belongs to a different species group, the *Aplopappi* of Steyskal (1984). The egg body of the stalked egg of *Paracantha gentilis* Hering (Headrick and Goeden 1990) is twice as long on average, and its pedicel is more than four times longer (about 2.5 times the length of its egg body) than eggs of *A. ferruginea* and *A. michaeli.*

Third instar: Third instar of *A. michaeli* superficially smooth, pyriform, tapering anteriorly, rounded posteriorly, abdominal segments III–V enlarged dorsally, minute acanthae ventrolaterally along intersegmental lines (Fig. 3A); gnathocephalon conical, flattened apically, rugose pads laterad of mouth lumen; elongated petals dorsad of mouth lumen (Fig. 3B-1); paired dorsal sensory organs dorsomediad of anterior sensory lobes, each consisting of a dome-shaped papilla (Fig. 3B-2, C-1); anterior sensory lobes (Fig. 3B-3) bear the terminal sensory organ (Fig. 3C-2), pit sensory organ (Fig. 3C-3), lateral sensory organ (Fig. 3C-4), and supralateral sensory organ (Fig. 3C-5); stomal sense organs ventrolaterad of anterior sensory lobes, near mouth lumen (Fig. 3D-1); lateral (Fig. 3D-2) and ventrolateral sensilla (Fig. 3D-3) located laterad and ventrolaterad, respectively, of the rugose pads, each consisting of a verruciform sensillum; mouth hooks tridentate, teeth conical, sharply curved downward, medial tooth reduced (Fig. 3B-4, D-4); median oral lobe laterally flattened, tapering apically, attached to labial lobe (Fig. 3B-5); prothorax smooth, minute acanthae ventrally (Fig. 3D-5); anterior thoracic spiracles dorsolaterad on posterior margin, consisting of three or four elongate-oval papillae (Fig. 3E); metathoracic lateral spiracular complex consists of an open spiracle (Fig. 3F-1) and a single verruciform sensillum (Fig. 3F-2); abdominal lateral spiracular complex consists of an open spiracle only; caudal segment bears the posterior spiracular plates (Fig. 3G); posterior spiracular plates bear three elongate-oval rimae ca. 0.038 mm in length (Fig. 3G-1), and four interspiracular processes with 1–3 branches each, longest measuring 0.01 mm (Fig. 3G-2); compound sensilla ventrad of posterior spiracular plate consist of a stelex sensillum (Fig. 3H-1) and a tuberculate, medusoid chemosensillum (Fig. 3H-2).

Third instar of *A. ferruginea* superficially smooth, oblong-elliptical, dorsally and ventrally rounded, minute acanthae ventrally (Fig. 4A); gnathocephalon conical, flattened apically, serrated rugose pads laterad of mouth lumen (Fig. 4B-1); paired dorsal sensory organs dorsomediad of anterior sensory lobes, each consisting of a dome-shaped papilla (Fig. 4B-2, C-1); anterior sensory lobes bear the terminal sensory organ (Fig. 4C-2), pit sensory organ (Fig. 4C-3), lateral sensory organ (Fig. 4C-4) and supralateral sensory organ (Fig. 4C-5); stomal sense organs ventrolaterad of anterior sensory lobes, near the mouth lumen (Fig. 4B-3); lateral (Fig. 4B-4) and ventrolateral sensilla (Fig. 4B-5) located laterad and ventrolaterad of rugose pads, respectively, each consisting of a verruciform sensillum; mouth hooks tridentate, medial tooth reduced, teeth stout, conical (Fig. 4D-1); median oral lobe laterally flattened, tapering anteriorly, attached to labial lobe (Fig. 4D-2); labial lobe bears two pore sensilla anteriorly (Fig. 4D-3); prothorax smooth, minute acanthae ventrally, single row of verruciform sensilla circumscribe prothorax; anterior thoracic spiracles dorsolateral on posterior margin, each consisting of five oval papillae (Fig. 4E); meso- and metatho-

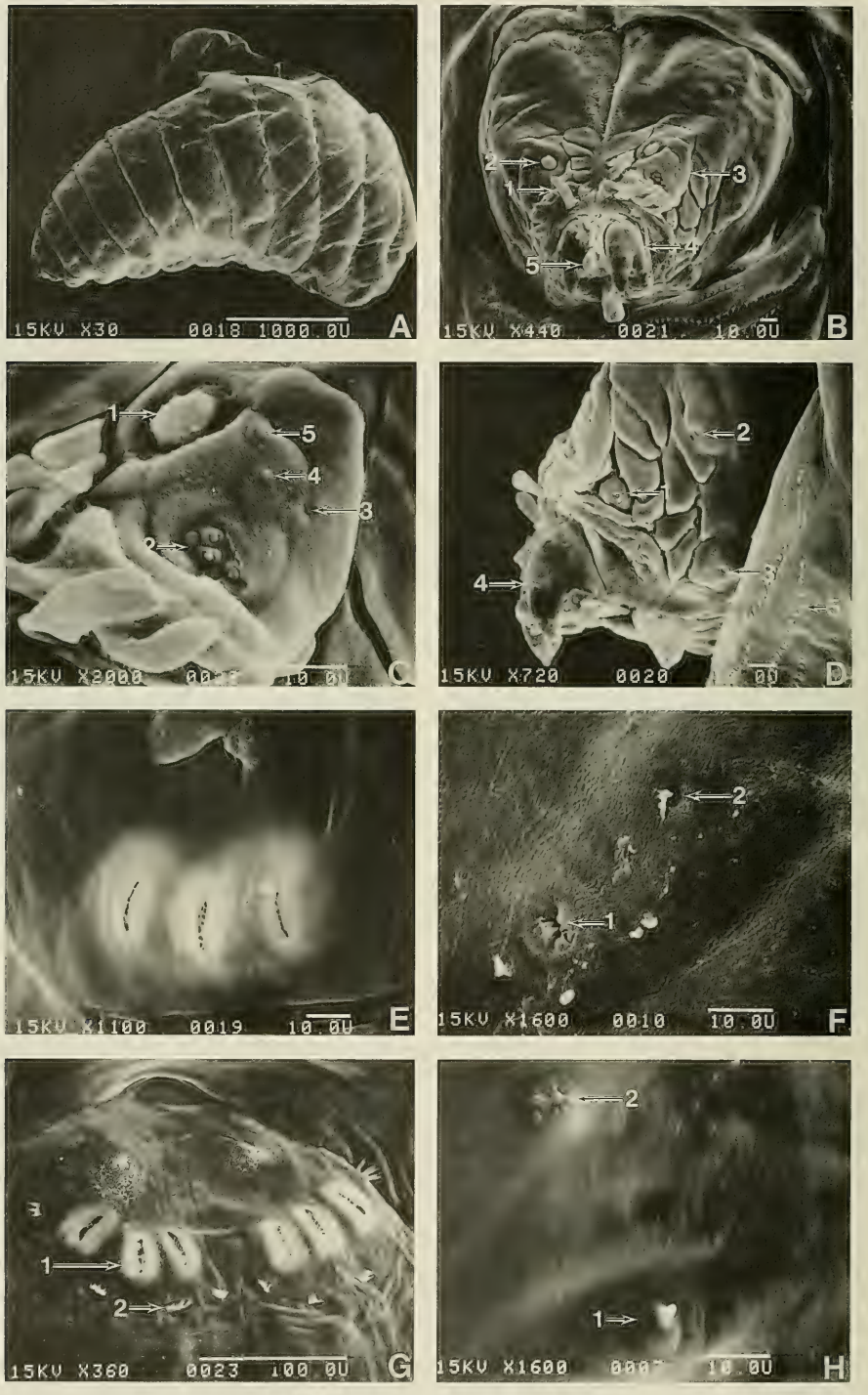

Fig. 3. Third instar of *Aciurina michaeli:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—elongated petals, 2—dorsal sensory organ, 3—anterior sensory lobe, 4—mouth hooks, 5—median oral lobe; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ; (D) gnathocephalon, lateral view, 1—stomal sense organ, 2—lateral sensillum, 3—ventrolateral sensillum, 4—mouth hooks, 5—minute acanthae; (E) anterior thoracic spiracle;

racic lateral spiracular complexes consist of an open spiracle (Fig. 4F-1), and three verruciform sensilla (Fig. 4F-2); caudal segment bears the posterior spiracular plates (Fig. 4G); posterior spiracular plates bear three oval rimae, ca. 0.036 mm in length (Fig. 4G-1), and four interspiracular processes with 3–8 branches each, longest measuring 0.024 mm (Fig. 4G-2); two compound sensilla ventrad of posterior spiracular plates (Fig. 4G-3), consist of a tuberculate chemosensillum (Fig. 4H-1), and a raised verruciform sensillum with a central papilla (Fig. 4H-2) in one, and a tuberculate chemosensillum and stelex sensillum in the other; stelex sensilla surround margin of caudal segment in 2-dorsal, 4-ventral arrangement.

The habitus of the third instar *A. michaeli* differs dramatically from that of *A. ferruginea.* The abdominal segments III–V in *A. michaeli* are greatly expanded dorsally, forming a distinct hump. Wangberg (1981) suggested that the hump was used to move inside the gall cavity. No previously examined Tephritidae has displayed a similar habitus (Goeden and Headrick 1990, 1991a, b, 1992; Goeden et. al 1993, 1994a, b; Headrick and Goeden 1990, 1991). *Aciurina ferruginea* closely resembles *A. thoracica* in general habitus (Headrick and Goeden 1993). The gnathocephalon of *A. michaeli* and *A. ferruginea* are very similar to each other, with only slight differences in the shape of the rugose pads. The prothorax in *A. ferruginea* is circumscribed by a single row of verruciform sensilla, but *A. michaeli* lacks such verruciform sensilla. The prothorax in *A. thoracica* has two rows of verruciform sensilla circumscribing the prothorax (Headrick and Goeden 1993). *Aciurina michaeli* differs from *A. ferruginea* and *A. thoracica* in the number of papillae in the anterior thoracic spiracles, three or four in *A. michaeli,* five in *A. ferruginea,* and four papillae each in *A. thoracica* (Headrick and Goeden 1993). The lateral spiracular complexes also differ among the three species. *Aciurina ferruginea* has three verruciform sensilla in the metathoracic lateral spiracular complex, *A. michaeli* has only one verruciform sensillum. *Aciurina thoracica* has one verruciform sensillum in the metathoracic lateral spiracular complex, but differs from *A. michaeli* in having one sensillum in the abdominal segments (Headrick and Goeden 1993). The caudal segment also differs slightly, the interspiracular processes have more individual branches in *A. ferruginea* than in *A. michaeli,* and stelex sensilla surround the caudal margin in *A. ferruginea. Aciurina thoracica* differs from *A. michaeli* and *A. ferruginea* in having very reduced interspiracular processes (Headrick and Goeden 1993).

Second instar: Second instar of *A. ferruginea* superficially smooth, oblong-elliptical, tapering anteriorly, rounded posteriorly, minute acanthae ventrally (Fig. 5A); gnathocephalon conical, rugose pads laterad of mouth lumen (Fig. 5B-1); petals dorsad of mouth lumen (Fig. 5B-2); paired dorsal sensory organs dorsomediad of anterior sensory lobes (Fig. 5B-3, C-1); anterior sensory lobes dorsolaterad of mouth lumen (Fig. 5B-4, C), bear the terminal sensory organ (Fig. 5C-2), pit sensory organ, lateral sensory organ (Fig. 5C-3), and supralateral sensory organ (Fig. 5C-4); stomal sense organs ventrolaterad of anterior sensory lobe, near mouth lumen (Fig. 5D-1); lateral (Fig. 5D-2) and ventrolateral (Fig. 5D-3) sensilla located laterally and ventrolaterally of rugose pads, respectively; mouth hooks bidentate, teeth conical, sharply pointed (Fig.

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(F) metathorax, lateral spiracular complex, 1—spiracle, 2—verruciform sensillum; (G) caudal segment, posterior spiracular plates, 1—rima, 2—interspiracular process; (H) caudal segment, compound sensillum, 1—stelex sensillum, 2—tuberculate medusoid chemosensillum.

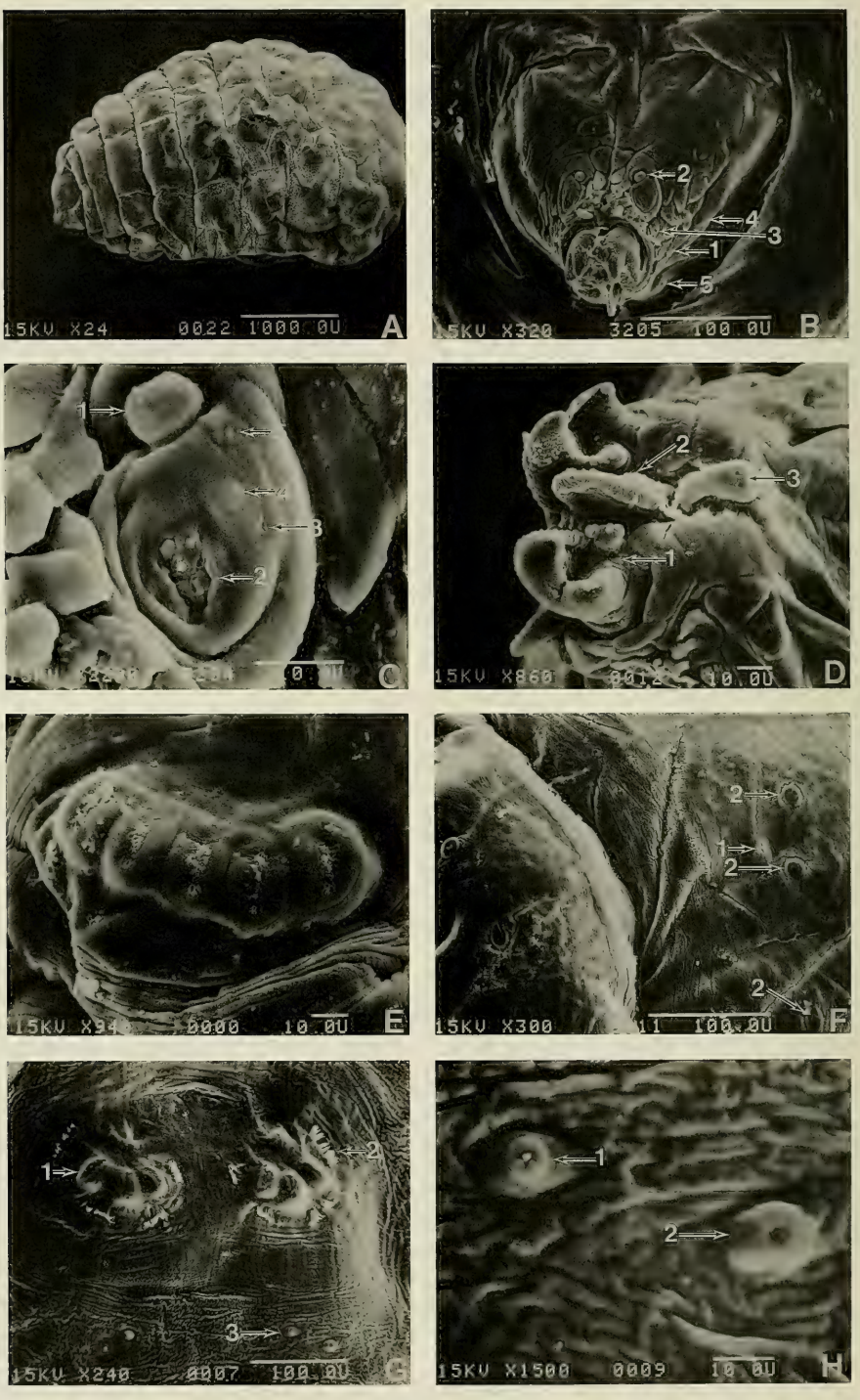

Fig. 4. Third instar of *Aciurina ferruginea:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—serrated rugose pads, 2—dorsal sensory organ, 3—stomal sense organ, 4—lateral sensillum, 5—ventrolateral sensillum; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ; (D) gnathocephalon, ventral view, 1—mouth hooks, 2—median oral lobe, 3—labial lobe pore sensilla; (E) anterior thoracic spiracle; (F) mesothorax and metathorax,

5D-4); median oral lobe laterally flattened, attached to labial lobe (Fig. 5D-5); labial lobe bears two pore sensilla anteriorly (Fig. 5D-6); prothorax smooth, minute acanthae ventrally, single row of verruciform sensilla circumscribe prothorax; anterior thoracic spiracles dorsolaterad on posterior margin of prothorax, papillae indistinct (Fig. 5E); meso- and metathoracic lateral spiracular complexes consist of an open spiracle (Fig. 5F-1), and two verruciform sensilla (Fig. 5F-2); caudal segment bears the posterior spiracular plates (Fig. 5G); posterior spiracular plates bear three oval rimae, ca. 0.012 mm in length (Fig. 5G-1), and four, blade-like interspiracular processes with 2–4 branches each, longest measuring 0.009 mm (Fig. 5G-2); compound sensilla ventrad of posterior spiracular plates (Fig. 5G-3), consist of a stelex sensillum (Fig. 5H-1) and a tuberculate chemosensillum with a central papilla (Fig. 5H-2); stelex sensilla surround margin of caudal segment (Fig. 5G-4).

The second instar of *A. ferruginea* differs slightly from the third instar. Most morphological features of the second instar are similar in shape and placement to those of the third instar, but not as structurally distinct as on the mature larva. Only two verruciform sensilla were observed in the lateral spiracular complex of the second instar; this may be due to the wrinkled nature of the specimen examined. The caudal segment of the two instars differed slightly. The posterior spiracular plates in the second instar were closer together, with smaller rimae and interspiracular processes with fewer branches. The compound sensilla in the second instar consisted of tuberculate chemosensilla and stelex sensilla, but no verruciform sensilla as observed in the third instar.

First instar. First instar of *A. ferruginea* superficially smooth, oblong-elliptical, tapering anteriorly, rounded posteriorly, minute acanthae ventrally (Fig. 6A); gnathocephalon conical, laterally flattened, smooth, lacking rugose pads (Fig. 6B); single pair of petals dorsad of mouth lumen (Fig. 6B-1); paired dorsal sensory organs dorsomediad of anterior sensory lobes (Fig. 6B-2, C-1); anterior sensory lobes (Fig. 6C) bear the terminal sensory organ (Fig. 6C-2), pit sensory organ (Fig. 6C-3), lateral sensory organ (Fig. 6C-4), and supralateral sensory organ (Fig. 6C-5); stomal sense organs indistinct, ventrolaterad of anterior sensory lobes (Fig. 6B-3); lateral and ventrolateral sensilla indistinct; mouth hooks bidentate, teeth conical, rounded apically (Fig. 6B-4); median oral lobe laterally flattened (Fig. 6B-5); prothorax smooth, minute acanthae ventrally; anterior thoracic spiracles absent; lateral spiracular complex not observed; caudal segment bears the posterior spiracular plates (Fig. 6D-1); posterior spiracular plates bear two, indistinct rimae (Fig. 6E-1), and four, spine-like interspiracular processes, longest measuring 0.008 mm (Fig. 6E-2); compound sensilla ventrad of posterior spiracular plates (Fig. 6D-2, E-3), consist of a stelex sensillum (Fig. 6F-1) and a tuberculate medusoid chemosensillum (Fig. 6F-2); two stelex sensilla dorsolaterad of posterior spiracular plates (Fig. 6D-3).

The morphological features of the first instar of *A. ferruginea* are much less distinct than those of the second and third instar. The gnathocephalon in the first instar lacks rugose pads, has a single pair of dorsal petals, and the stomal sense organs, lateral and ventrolateral sensilla are indistinct. The respiratory system undergoes major morphogenesis between the first and second instars. In the first instar, the anterior spir-

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lateral spiracular complex, 1—spiracle, 2—verruciform sensilla; (G) caudal segment, posterior spiracular plates, 1—rima, 2—interspiracular process, 3—compound sensillum; (H) caudal segment, compound sensillum, 1—tuberculate chemosensillum, 2—verruciform sensillum.

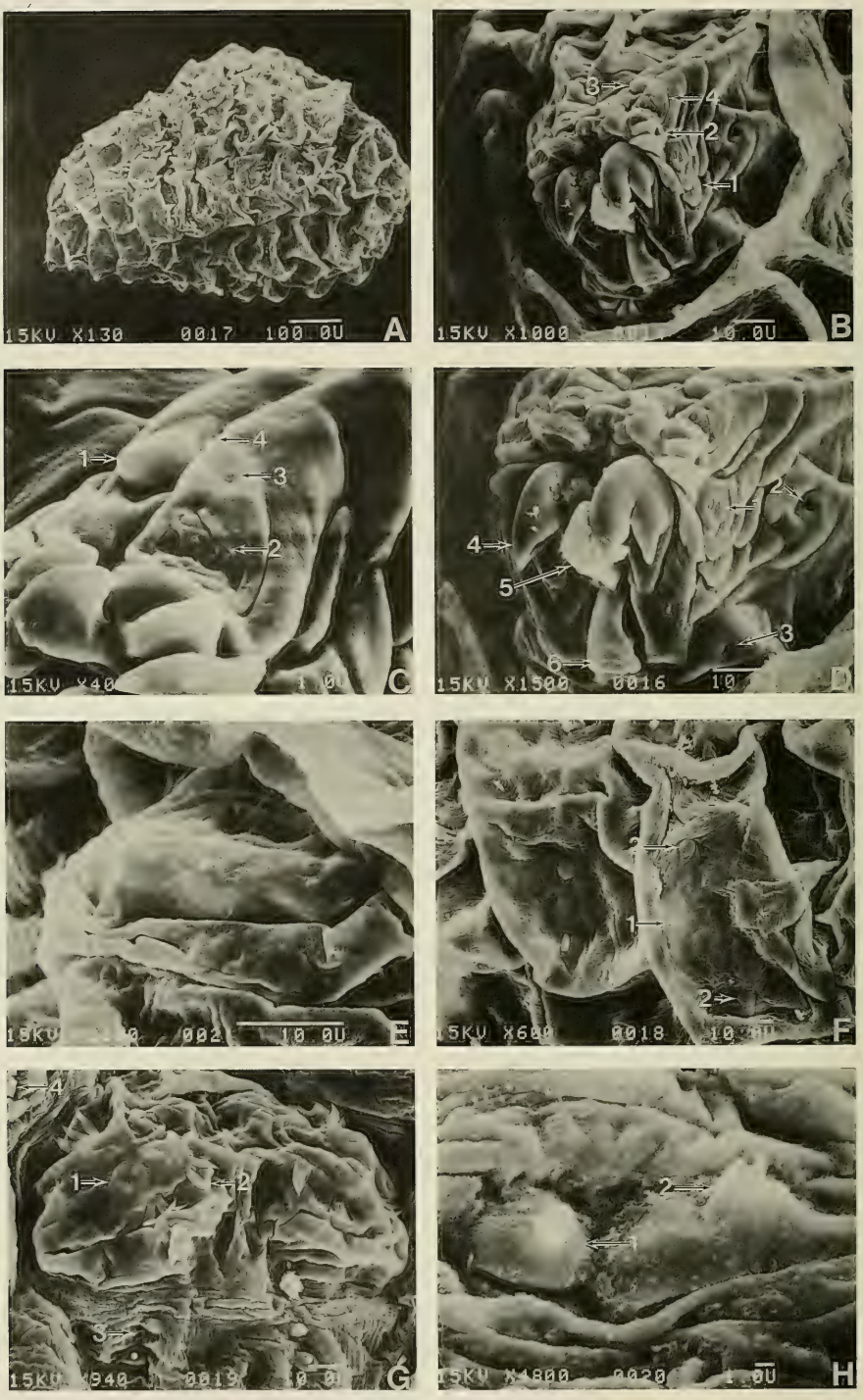

Fig. 5. Second instar of *Aciurina ferruginea:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—rugose pads, 2—dorsal petals, 3—dorsal sensory organ, 4—anterior sensory lobe; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—lateral sensory organ, 4—supralateral sensory organ; (D) gnathocephalon, anterior view, 1—stomal sense organ, 2—lateral sensillum, 3—ventrolateral sensillum, 4—mouth hooks, 5—median oral lobe, 6—labial lobe pore sensilla; (E) anterior thoracic spiracles; (F) mesothorax

acles are not present and the posterior spiracular plates possess only two small rimae. The lateral spiracular complex was not observed in this species but has been observed in other first instar tephritid larvae, e.g. Knio et al. (1996). The compound sensilla in the first instar larva are more distinct than in the second and third instar.

Puparium: Puparium of *A. michaeli* smooth, elongate-reniform, light to reddish-brown (Fig. 7A); anterior end bears the anterior thoracic spiracles (Fig. 7B-1), and invagination scar (Fig. 7B-2); anterior thoracic spiracles and invagination scar darkened; caudal end bears the posterior spiracular plates (Fig. 7C); plates darkened, bear three oval rimae, ca. 0.032 mm in length (Fig. 7C), and four interspiracular processes.

The puparium of *A. ferruginea* differs from *A. michaeli* in being smooth, elongate ovoidal, pale yellow, anterior end around invagination scar darkened; 100 specimens averaged 3.38 ± 0.05 (range, 2.54–4.42) mm long by 1.68 ± 0.03 (range, 1.16–2.24) mm wide (Fig. 7D); anterior end bears the invagination scar (Fig. 7E-1), prothoracic verruciform sensilla, which are lacking in *A. michaeli* (Fig. 7E-2), and the anterior thoracic spiracles (Fig. 7E-3); caudal end bears the posterior spiracular plates (Fig. 7F); plates bear three oval rimae, ca. 0.035 mm in length (Fig. 7F-1), and four interspiracular processes (Fig. 7F-2).

Distribution and Hosts

Foote et al. (1993) mapped the distribution of *A. ferruginea* in North America north of Mexico to include Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. This reflects the combined distributions of all four subspecies of *C. viscidiflorus* described by Munz (1974). Galls of *A. ferruginea* and *A. michaeli* occur in sympatry on *C. viscidiflorus* in central and southern California, and indeed, have been found by us on the same host individuals. Swept specimens of both species of tephritids were examined from Washington during the present study, and galls of both species were pictured by Wangberg (1981) from Idaho, so these two tephritids probably occur in sympatry throughout the range of *C. viscidiflorus.* Wasbauer (1972) and Steyskal (1984) cited Foote and Blanc (1963) as the source of additional rearing records from *Haplopappus bloomeri* Gray (as *Chrysothamnus bloomeri*) and *Solidago* sp. To this host list for what was then solely called *A. ferruginea,* Steyskal (1984) added *Chrysothamnus nauseosus* (Pallen) Britton. Conceivably, *A. ferruginea* and *A. michaeli* may have different host ranges, but it is difficult to imagine that the distinctive galls of these two species, especially those of *A. ferruginea* (as interpreted in the present study), have been overlooked on hosts other than *C. viscidiflorus.* It also is conceivable that the flies reported in Foote and Blanc (1963) had been swept, not reared, or reared from *Chrysothamnus* hosts misidentified as *Haplopappus* or *Solidago.* The large genus *Haplopappus* (Munz 1974) heretofore has appeared to us to be amazingly free of tephritid galls in southern California, except for the few *Procecidochares* spp. found in flower heads currently under study (Goeden and Teerink, unpublished data). However, records for *A. aplopappi* (Coquillett) from *Haplopappus pinifolius* Gray and for *A. bigeloviae* (Cockerell) from *Haplopappus* sp. (Wasbauer 1972, Steyskal 1984) encountered during this writing render the record for *A. ferruginea* from *H. bloomeri* less suspect than the record from *Solidago.* Con-

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and metathorax, lateral spiracular complex, 1—spiracle, 2—verruciform sensilla; (G) caudal segment, posterior spiracular plates, 1—rima, 2—interspiracular process, 3—compound sensillum, 4—stelex sensillum; (H) compound sensillum, 1—stelex sensillum, 2—tuberculate chemosensillum.

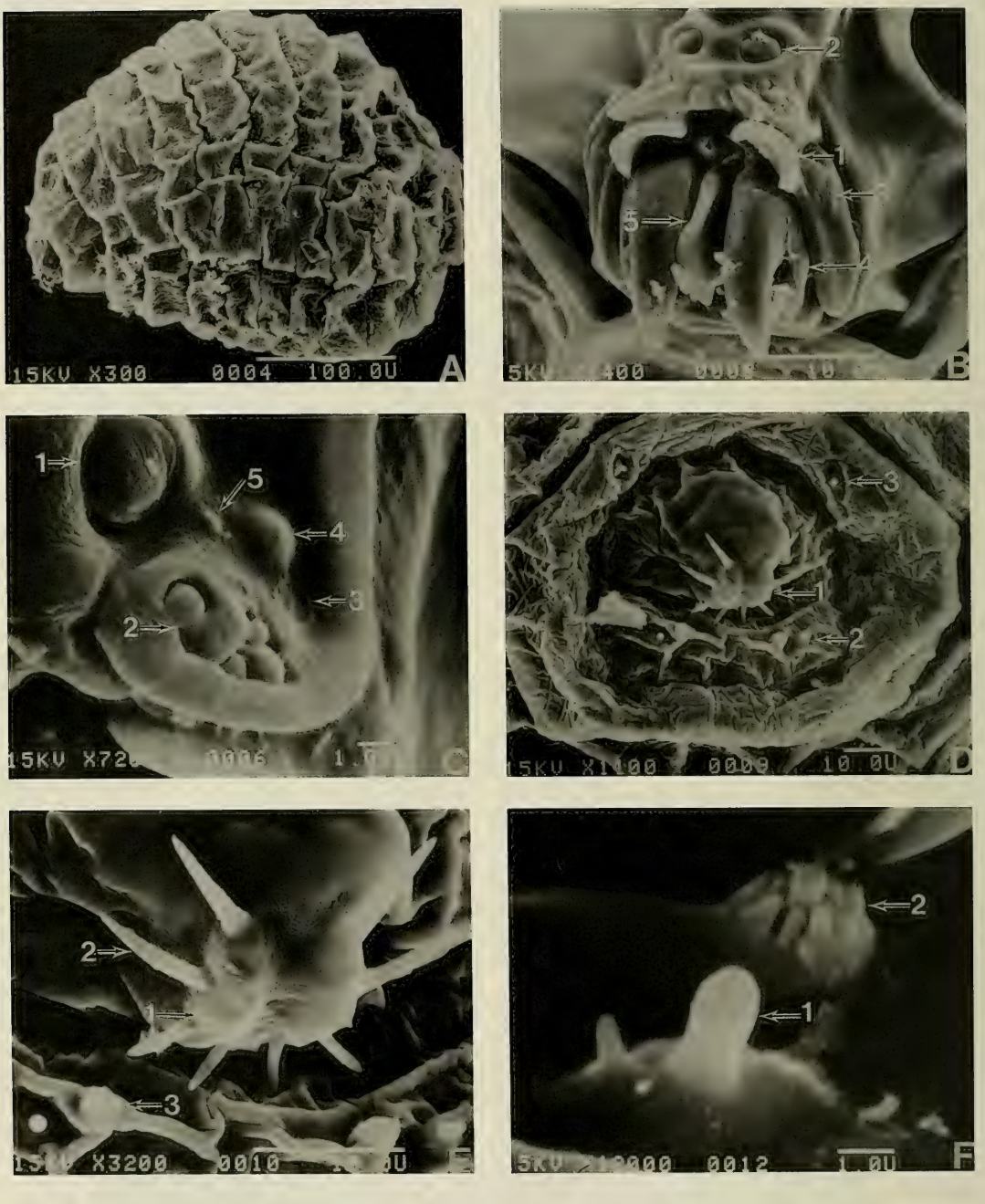

Fig. 6. First instar of *Aciurina ferruginea:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—dorsal petal, 2—dorsal sensory organ, 3—stomal sense organ, 4—mouth hooks, 5—median oral lobe; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ; (D) caudal segment, 1—posterior spiracular plates, 2—compound sensillum, 3—stelex sensillum; (E) posterior spiracular plate, 1—rima, 2—interspiracular process, 3—compound sensillum; (F) compound sensillum, 1—stelex sensillum, 2—tuberculate medusoid chemosensillum.

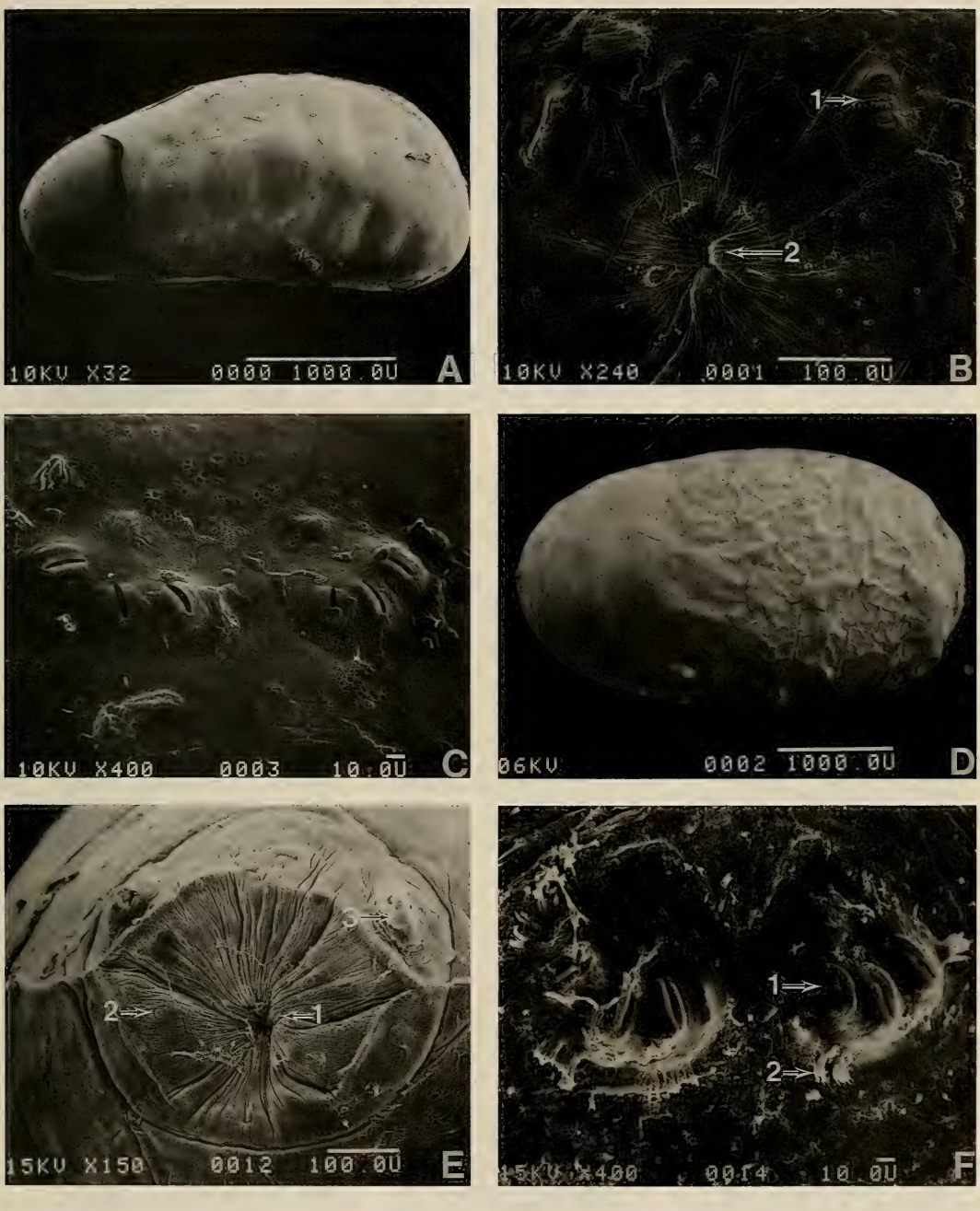

Fig. 7. Puparia of *Aciurina michaeli* and *A. ferruginea:* (A) *A. michaeli,* habitus, anterior to left; (B) *A. michaeli,* anterior end, 1—anterior thoracic spiracles, 2—invagination scar; (C) *A. michaeli,* caudal segment, posterior spiracular plate; (D) *A. ferruginea,* habitus, anterior to left; (E) *A. ferruginea,* anterior end, 1—invagination scar, 2—prothoracic verruciform sensilla, 3—anterior thoracic spiracles; (F) *A. ferruginea,* caudal segment, 1—rima, 2—interspiracular processes.

Fig. 8. Life stages of *Aciurina ferruginea* and *A. michaeli* on *Chrysothamnus viscidiflorus:* (A) pedicel and anterior part of body of egg of *A. ferruginea* projecting from axillary bud, (B) first instar of *A. ferruginea* (arrow) in early-stage gall, (C) young gall with late-first instar *A. ferruginea,* (D) sagittal section of gall containing second instar of *A. ferruginea* in locule inside basal core from which filamentous leaves arise, (E) sagittal section through mature, beaked gall of *A. michaeli* containing a puparium, (F) four mature galls of *A. ferruginea* on

sequently, we will redouble our efforts to detect their galls and rear *Aciurina* from *Haplopappus* in southern California. The host ranges of *A. ferruginea* and *A. michaeli* obviously warrant further study, but ultimately may be unresolvable, if, as suspected, they are based in part on records for misidentified host plants or flies or sweep records misinterpreted as rearing records, as sometimes confounds the literature on host plants of Tephritidae.

Biology

Egg.—Dissection of current year's flowering and vegetative branches sampled on 14.viii.1993 and 18.ix.1993 from postblossom plants bearing mature flower heads, senescent foliage, and empty, brownish, current season's galls at the study site S of Wongo Peak yielded eggs of *A. ferruginea* (Fig. 8A). But these empty galls were like those described below for *A. ferruginea* (Fig. 8D, F), not like those described and illustrated by Tauber and Tauber (1967) and Wangberg (1981), which instead apply to galls of *A. michaeli* (Fig. 8E). Adults of neither *A. ferruginea* nor *A. michaeli* were swept from *C. viscidiflorus* on either date at this location, and because this site had a light dusting of snow on the second sampling date, oviposition likely had ceased by then. The plants sampled also had been noted to bear galls of *A. ferruginea* during 1991 and 1992; therefore, certain individuals within the local host population apparently were favored for oviposition on successive years, as recently reported for *Euaresta stigmatica* Coquillett by Headrick et al. (1995).

Three eggs of *A. ferruginea* were found in the sample collected on 14.viii.1993 and 12 eggs in the sample collected on 18.ix.1993. All eggs were oviposited singly in individual axillary buds (Fig. 8A). The long axis of each egg body lay parallel to the branch or bud long-axis. The posterior end of the egg body was inserted downward between the apical pair of unexpanded leaves of a bud or between an adaxillary leaf and branch (Fig. 8A); consequently, the anterior end of the egg body and the entire egg pedicel, or the pedicel alone, were exposed and the latter part projected upward from the branch or bud apex (Fig. 8A). The eggs did not penetrate the tissues of the bud or branch. The egg bodies and basal part of the pedicel became covered with a sticky, plant-produced resin, but the upper part of the pedicel of most eggs remained free; therefore, the elongate pedicel presumably has an important respiratory function (Fig. 2B, D, 8A). Some collapsed and presumably infertile, smothered or otherwise nonviable eggs were completely embedded in the resin that covered the surface of current year's branches of *C. viscidiflorus*. This account of egg placement agrees with the description by Tauber and Tauber (1967).

Larva.—Part of the second, egg-bearing, branch sample was held as a bouquet immersed in a container of water in a refrigerator at 2 ± 2°C until 11.x.1994. This allowed embryogenesis to proceed slowly, evidenced by the mouth hooks seen on one embryo that had reversed its orientation 180° preparatory to eclosion from the posterior end of the egg. Moreover, three of eight (37.5%) eggs found in buds dissected on this date had hatched and the first-instar larvae had fed downwards into the buds. This confirmed that the overwintering stage for *A. ferruginea* mainly is the first instar, as first suggested by results of a series of bi-monthly samplings and dissections of developing galls conducted in 1992. Because of winter-like road conditions, we first could visit the high-altitude study site S of Wongo Peak on 22.iv.1992, fortuitously,

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single branch of *C. viscidiflorus*, (G) full-size, third instar of *A. ferruginea*, (H) puparium of *A. ferruginea*, (I) adult female of *A. ferruginea*. Line = 1 mm.

just when roadside plants of *C. viscidiflorus* were beginning to resume branch growth. Likewise, the galls of *A. ferruginea* and *A. michaeli* were just beginning to grow. All 20 incipient galls found on branches sampled on this date contained single first instars of either *A. ferruginea* or *A. michaeli,* the principal overwintering stage for both fly species. At this early stage, the galls of these species looked very similar; although, the leafy nature of the galls of *A. ferruginea* (Fig. 8B) was already distinguishable from the few-leafed, smooth, eventually "beaked" galls of *A. michaeli* (Fig. 8E). The subspherical locules in each of three galls that contained early-first instars of *A. ferruginea* (Fig. 8B) averaged 0.67 ± 0.46 (range, 0.60–0.76) mm by 0.59 ± 0.77 (range, 0.48–0.78) mm. The subspherical central chambers of 17 galls that contained individual first instars of *A. michaeli* measured 0.48 ± 0.02 (range, 0.32–0.64) mm by 0.44 ± 0.03 (range, 0.32–0.70) mm. The galled axillary buds presumably containing early-first instars of *A. ferruginea* externally measured 4.99 ± 0.96 (range, 3.77–6.89) mm long by 3.28 ± 0.40 (range, 2.72–4.05) mm wide and were located an average of 13 ± 1.5 (range, 11.5–16.0) cm below the apex of the branch on which they were formed (at the ovipositional sites). The 12 axillary buds and one apical bud presumably galled by early-first instars of *A. michaeli* measured 5.12 ± 0.39 (range, 2.51–8.0) mm long by 2.46 ± 0.13 (range, 1.67–4.0) mm; the galled axillary buds (ovipositional sites) were located 10 ± 1.3 (range, 4.0–18.0) cm below the apical bud.

The next sample collected on 7.v.1992 consisted solely of 30 *A. ferruginea* galls (Fig. 8C) each containing single, late-first or early-second instars, as by then these galls were readily distinguishable from those of *A. michaeli* (Fig. 8E), which, again, was not studied because we assumed that it was the former species that already had been studied by Tauber and Tauber (1967). Only five galls (16.7%) in this sample contained early second instars; the remaining 25 galls (83.3%) contained late-first instars. The next sample collected on 21.v.1992 comprised two late-first instars (12.5%) and 14 early-second instars (87.5%). Twenty-seven galls containing late-first instars from 7.v.1992 and 21.v.1992 samples, externally measured 6.0 ± 0.3 (range, 3.5–9.0) mm long by 5.8 ± 0.3 (range, 3.0–9.0) mm wide by 4.2 ± 0.2 (range, 2.5–6.0) mm thick. They were located 10.9 ± 0.6 (range, 7.0–17.5) cm below the vegetative branch apices or immature, compound inflorescences terminating some branches. By this time, the galls already appeared very leafy and consisted of stunted axillary branches, which continued to produce leaves in fascicles from many tiny axillary buds as the galls grew (Fig. 8D). The outer, nonserrate margined, linear leaves averaged 9.9 ± 0.8 (range, 3.4–18.0) mm in length and 2.1 ± 0.13 (range, 0.5–3.0) mm in width; the inner leaves, 4.3 ± 1.4 (range, 2.1–7.0) mm long by 0.6 ± 0.05 (range, 0.3–1.5) mm wide (n = 25). The basal locule was ovoidal in shape and 0.75 ± 0.035 (range, 0.41–1.25) mm long by 0.49 ± 0.014 (range, 0.41–0.67) mm wide (n = 25) by 0.36 ± 0.037 (range, 0.23–0.42) mm deep (n = 5). Its inner surface is shallowly pitted and thinly coated with sap upon which the larvae principally feed, as described for *A. thoracica* by Headrick and Goeden (1993). This cavity was surrounded by a parenchymatous, ellipsoidal core, 0.44 ± 0.04 (range, 0.31–0.55; n = 5) mm thick composed of the hollowed, laterally expanded, but shortened branch cortex within which the larvae fed, and which at this early stage of gall development measured only 1.62 ± 0.09 (range, 1.42–1.84) mm long by 1.46 ± 0.16 (range, 1.06–1.75) mm wide in cross section.

Seventeen galls of *A. ferruginea* containing late-second instars from the samples of 21.vi.1992 and 10.vi.1992 measured 9.0 ± 0.6 (range, 5.0–13.0) mm long by 9.2 ± 0.5 (range, 6.0–13.0) mm wide by 5.6 ± 0.6 (range, 3.0–10.0) mm in thickness. The smooth-surfaced, ellipsoidal, basal locule

measured 1.36 ± 0.11 (range, 0.83–2.31) mm long by 0.77 ± 0.05 (range, 0.5–1.2) mm wide in cross section, and each was surrounded by a 0.59 ± 0.03 (range, 0.42–0.86) mm-thick inner core which measured 2.39 ± 0.12 (range, 1.56–3.44) mm long by 2.00 ± 0.08 (range, 1.48–2.58) mm wide. The core bore a profusion of smooth, threadlike leaves, 7.1 ± 0.7 (range, 3.8–10) mm long and 0.65 ± 0.63 (range, 3.8–1.0) mm wide (n = 11). Sixteen (94%) of these bud galls were axillary; one was apical. The axillary bud galls were located 8.0 ± 0.1 (range, 3.5–16.0) cm below the branch apex or terminal, immature inflorescence.

The gall samples of 10.vi.1992 and 23.vi.1992 from the high-altitude study site S of Wongo Peak each contained two late-second instars (7%) and 28 early-third instars (93%). However, 30 galls sampled on 24.vi.1992 at lower elevations at Long Valley and Kennedy Meadows both contained mid- to full-size, third instars (Fig. 8G) and puparia (Fig. 8H) [3 (10%) and 9 (30%), respectively]. The 30 galls in the 9.vii.1992 sample from S of Wongo Peak also contained nine (30%) puparia. One hundred mature galls each containing a single puparium of *A. ferruginea* (Fig. 8H) collected from these and other locations sampled on 9.vii.1992 averaged 15 ± 0.2 (range, 12–19) mm in length and 14 ± 0.2 (range, 10–18) mm in diameter. The mean (10.7 mm) and range (6–15 mm) of 10 galls containing third instars reported by Wangberg (1981) were smaller than those that we measured containing puparia. The basal ovoidal, smooth-walled locule measured 4.69 ± 0.07 (range, 3.44–6.51) mm long by 2.03 ± 0.34 (range, 1.52–4.31) mm in diameter at one end of which the fully grown larva before it had pupariated had excavated a thin, circular, epidermal, 1.13 ± 0.016 (range, 0.86–1.46; n = 92) mm diam window in the otherwise 0.85 ± 0.16 (range, 0.53–1.25)-mm thick, inner core of the gall that surrounded the locule. This hard ellipsoidal core measured 5.46 ± 0.63 (range, 4.31–7.15) mm long by 3.74 ± 0.04 (range, 2.09–4.75) mm wide and bore the profusion of filamentous leaves that constituted the bulk of these highly distinctive, foliose-appearing tephritid galls (Fig. 8D, F). This gall was first described by Wangberg (1981), who apparently failed to identify the adults he "rarely reared", and did not observe in the field, other than as "*Aciurina* sp. B". Steyskal (1984) indicated that "Sp. B" of Wangberg (1981) "likely" was *A. idahoensis,* and conspecific with "Sp. A" of Wangberg (1981); whereas, the present study has demonstrated that the former assumption was wrong. Moreover, our unpublished data show that "*Aciurina* sp. A and sp. B" of Wangberg (1981) are not conspecific. Instead, the former species is *A. idahoensis,* which in California, though apparently not in Idaho (Steyskal 1984), has a strongly sexually dimorphic wing pattern. The life history, adults and immature stages of *A. idahoensis* in southern California will be described in our next paper in this series. The gall of *A. ferruginea* (Fig. 8D, F) is unique among those described for *Aciurina,* and apparently among other gallicous Tephritidae to date (Friedberg 1984).

Of 312 galls collected on 225 excised, current season's branches in 1992 and 1993, 169 (75.1%) branches bore single galls; 31 (13.7%) branches bore two galls each; 20 (8.9%) branches had three galls each; four (1.8%) branches had four galls each; and only one branch had five galls. If formed on adjacent or nearby axillary buds, the leafy portions of one or more galls combined to form compound galls, within which each larva or puparium was retained in its separate locule. Accordingly, the five galls on the single branch noted above formed a single, compound gall 6-cm long.

Again, the galls of *A. michaeli* were described in considerable detail by Tauber and Tauber (1967) and Wangberg (1981) as those of *A. ferruginea.*

Pupa.—Pupariation occurs within the locule, with the anterior end of the puparium facing the window (Fig. 8H). Most locules and puparia were oriented with their

long axes perpendicular to the branches on which they were formed, but a few locules and puparia were formed nonperpendicular to the branch axis.

Adult.—The emerging adult broke through the thin epidermal window and exited the gall through an outwardly expanding, funnel-shaped channel in the leafy investiture of the gall by pushing aside and outward the leaves surrounding the window. Males were reared from galls in far greater numbers than females during 1991 and 1992, i.e. a total of 41 males to 11 females (3.7:1). Longevities of these 41 males caged in the insectary averaged 44 ± 5 (range, 4–105) days; longevities of these 11 females (Fig. 8I), 52 ± 8 (range, 2–99) days. Newly emerged females were sexually immature, but rapidly elaborated as many as 80 full-size ova in as few as 9 days (n = 7) after their emergence from galls.

Seasonal history.—*Aciurina ferruginea* and *A. michaeli* are both univoltine on *C. viscidiflorus* in California. Both species probably overwinter as first instars in incipient galls, similar to *Procecidochares* sp. on *Ambrosia dumosa* (Gray) Payne as reported by Silverman and Goeden (1980). However, Tauber and Tauber (1967) from egg collections like ours in September, deduced that the first instar was the overwintering stage for the species that they studied as *ferruginea.* The possibility exists that the egg eclosion that we obtained in refrigerated bouquets in October was an artifact, because we also have observed in the field that *Procecidochares minuta* (Snow) on *Chrysothamnus nauseosus* overwinters as a fully formed first instar within the intact egg chorion. Wangberg (1981) suggested that both of these *Aciurina* spp. overwintered as eggs in Idaho. Dissection of egg or first instar bearing axillary buds on previous season's branches collected in mid-winter would be the only way to settle this point of contention. Depending on which interpretation is correct, gall development begins when eggs hatch, or development of first instars accelerate, concurrently with resumed host-plant branch growth in early spring (in April at our study sites). Three larval stages are followed by pupariation in late June to early July. Adults emerge in July and August, mature sexually in about 10 days, mate, then oviposit concurrently with host-plant flowering and cessation of branch elongation. Oviposition largely takes place in newly formed, axillary buds usually basally on current year's branches of *C. viscidiflorus.* This type of life history strategy involving oviposition on host plants in a suitable stage upon fly emergence has been called "circumnatal" by Headrick and Goeden (1995) and is characteristic of many, but not all (unpublished data), gallicolous Tephritidae native to California. Whether additional generations of *A. ferruginea* and *A. michaeli* are produced on other species of host plants is unknown and warrants further field study.

Natural enemies.—Wangberg (1981) reported six species of Hymenoptera parasitoids "associated with galls from laboratory rearings" of *A. michaeli* labelled, described, and illustrated as galls of *A. ferruginea* in his report: *Eupelmus* sp. (Eupelmidae), *Eurytoma* sp. (Eurytomidae), *Halticoptera* sp. (Pteromalidae), *Tetrastichus cecidophagus* Wangberg (Eulophidae), *Torymus* sp. (Torymidae). He also reported the following Hymenoptera as associated with galls of *A. ferruginea* (his *Aciurina* sp. B) from rearings made by E. J. Allen in 1966: *Eupelmus* sp., *Habrocytus* sp. (Pteromalidae), *Torymus* sp., and *Zatropis* "*albiclavatus*" [*alboclavus* (Girault)?] (Pteromalidae). We, in turn, have reared the following parasitoids in southern California from *A. michaeli*: *Baryscapus* sp. (Eulophidae, Tetrastichinae), a gregarious, primary, larval-pupal endoparasitoid; an unidentified Tetrastichinae, a gregarious, primary, larval-pupal endoparasitoid; and two *Halticoptera* spp., as primary, solitary, larval-pupal endoparasitoids. From *A. ferruginea,* we reared the same two *Halticoptera* spp. and an unidentified, primary, solitary, larval ectoparasitic Torymidae. The two *Halticoptera* spp. were

by far the most common parasitoids reared from both *A. ferruginea* and *A. michaeli.*

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NOTES ON *CERATAPHIS BRASILIENSIS* AND SYNONYMS *PALMAE, VARIABILIS* AND *FRANSSENI* (HOMOPTERA: APHIDIDAE), WITH A KEY TO *CERATAPHIS* SPECIES LIVING ON PALMS AND ORCHIDS

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Abstract.—*Cerataphis brasiliensis* (Hempel) is established as a valid species. This specific name predates *Cerataphis palmae* (Ghesquière), *Cerataphis variabilis* Hille Ris Lambers and *Cerataphis fransseni* (Hille Ris Lambers) which are considered synonyms of *C. brasiliensis.* The availability of topotypes of *C. brasiliensis* and syntypes of *C. palmae* is disclosed, lectotypes and paralectotypes of *C. palmae* and *C. variabilis* are designated, and the life cycle of *C. fransseni* is noted. A key is provided for the identification of species of *Cerataphis* living on palms and orchids.

Key Words: Aphididae, *Cerataphis,* aphids, synonyms, lectotypes, paralectotypes, topotypes, palms, orchids, key

The objectives of this article are to establish the validity of *Cerataphis brasiliensis* (Hempel) as the correct name of a palm-inhabiting aphid, to indicate synonymy of three names, to designate lectotypes and paralectotypes of two species and provide a key for the identification of species of *Cerataphis* found on palms and orchids.

Cerataphis brasiliensis (Hempel) (Figs. 1, 2)

Ceratovacuna brasiliensis Hempel 1901: 384–385.

Cerataphis brasiliensis (Hempel); Embleton 1903: 95–96.

Aleurocanthus palmae Ghesquière 1934: 30.

Cerataphis palmae (Ghesquière); Ghesquière 1947: 177, 282, *in* Lepesme; **new synonym** of *C. brasiliensis.*

Cerataphis variabilis Hille Ris Lambers 1953: 95; **new synonym** of *C. brasiliensis.*

Astegopteryx fransseni Hille Ris Lambers 1933: 1–3.

Cerataphis fransseni (Hille Ris Lambers) 1953: 2; **new synonym** of *C. brasiliensis.*

Early in this century several workers, including Embleton (1903), Schouteden (1906), Moreira (1925) and Theobald (1929) listed *C. brasiliensis* as a synonym of *Cerataphis lataniae* (Boisduval 1867). Bondar (1926), however, recognized *brasiliensis* as a valid species. Hille Ris Lambers (1953) stated that *Cerataphis orchidearum* (Westwood 1879) "is also known as *Ceratovacuna brasiliensis.*" The latter action was followed by Holman (1974) and Eastop and Hille Ris Lambers (1976), but it is not acceptable when the description of *brasiliensis* is examined critically.

Hempel's description of the wingless adult of *C. brasiliensis* stated, "On the anterior margin of the abdominal [*lapsus calami,* correct abdominal to cephalic] surface there are two stout horns or spines, varying from 68–80 microns in length. The ventral

Figs. 1, 2. *Cerataphis brasiliensis,* topotypes. 1, Head and prothorax: antennae 5 segmented; 2 pairs of spines, 1 pair of setae, each with tuberculate base, proximad of antennae. 2, Body outline.

surface also bears two stout lance-shaped spines and four stout hairs near the base of the antennae. Antennae of four joints." Regarding the "larva" of the winged form, Hempel wrote, "On the ventral surface near the anterior margin there are two groups of three spines each. These spines are tuberculate and lance-shaped, one pointing forward, the other two downward." His collection data for *C. brasiliensis* were "Campinas, Brazil, on a species of palm; S. Paulo, on another species of palm, on a species of *Epidendron,* and on *Cattleya Harrisonia.*"

Hempel unknowingly included a species from palms and one from orchids in the description. But the relevant characters are the stout, lance-shaped spines and setae with tuberculate bases that may be present in specimens on palms but are absent from specimens on orchids. Four or five antennal segments occur in specimens on palms and four may be present in specimens on orchids, but five are more common. These characteristics place *brasiliensis* with specimens described as *C. palmae* and *C. variabilis,* and separate it from *C. lataniae* and *C. orchidearum.*

In the following discussions, the three pairs of characteristic processes proximad of the antennae are called spines if they are short and dagger- or lance-shaped and setae if they are long and slender.

After diligent search, type specimens of *C. brasiliensis* have not been found in Brazil or North America and they are presumed to have been lost. Fortunately, topotypes of *brasiliensis* are available. I have examined one partial and three complete adult apterae labeled "on *Cocos nucifera* L., Campinas, Brazil, 18-VIII-1942, H. F. G. Sauer." The specimens have large cephalic horns, 72–84 μ long, wax glands around the body margin except at the cephalic horns; cornicles rather near the body margin, each with two to four setae 12–16 μ long. Two specimens have four and two have five segmented antennae.

In the two specimens with four segmented antennae, the posterior spines proximad of the antennae in each and the middle spines in one are short and stout with strongly tuberculate bases, and the anterior setae in each and the middle setae in one are long and slender with weakly tuberculate bases. These specimens, especially the one with middle and anterior elongate setae and posterior spines are characteristic of *C. palmae.*

In the two specimens with five segmented antennae the posterior and middle spines are short and stout with strongly tuberculate bases while the anterior setae are longer and more slender but also have tuberculate bases as is the condition in some syntypes of *C. variabilis.* The distal rostral segment is five-seventh the length of second hind tarsus. The cauda has six setae. These specimens are similar to syntypes of *C. palmae* but vary from most syntypes of *C. variabilis* that I have seen.

Cerataphis palmae (Ghesquière)
(Figs. 3, 4)

Ghesquière (1934) described the wingless forms of *C. palmae* as follows (translation): "The larvae and the nymphs are black, surrounded by a white fringe, the nymphs measure 1.5 mm long by 1 mm wide." Ghesquière (1947) stated that he had described *Cerataphis lataniae* as *Aleurocanthus palmae* and that Risbec (1942) had described *lataniae* as *Aleurocanthus* sp.

Cerataphis palmae was disregarded until Eastop and Hille Ris Lambers (1976) listed it as a valid species and synonymized *C. variabilis* with it. Thereafter it was treated as a valid species by Blackman and Eastop (1985), Enobakhare (1986), Enobakhare and Osisanya (1986) and Noordam (1991). Remaudière and Autrique (1985), and Remaudière, Martin and Eastop (1987) noted that *palmae* cannot be identified from its description and that the name is a *nomen dubium.* Syntypes of *palmae* are available, however, and its identity can be determined.

Figs. 3, 4. *Cerataphis palmae,* lectotype. 3, Head and prothorax: antennae 4 segmented; 1 pair of spines each with tuberculate base, 2 pairs of setae each with slightly tuberculate base, proximad of antennae. 4, Body outline.

Many years ago I received *Aleurocanthus palmae* for identification in a parcel of aleyrodids collected in Congo belge. I recognized *palmae* as an aphid and was given permission to retain specimens for study. I corresponded with Hille Ris Lambers about the species and expected to publish on it at that time but did not do so.

Ghesquière (1934) stated that *Aleurocanthus palmae* was widespread at Kasai and Sankuru [Congo belge] on *Raphia vinifera* and that it had been observed on *Elaeis* growing near *Raphia.* Syntypes of *Cerataphis palmae* are labeled "on *Raphia vinifera,* Kole (Sankuru), II 1928, J. Ghesquière" or "Kole (Sankuru) or Kasai." No material is labeled as being on *Elaeis.* I have studied this material and have concluded that the specimens are conspecific with *C. brasiliensis* and that *palmae* is a synonym of *brasiliensis.*

Syntypes of *C. palmae* are ovoid, 1.10–1.50 mm long by 0.95–1.25 wide and are nearly uniform in structure. The cephalic horns are large and protrude from the ventral margin; wax glands may extend around the entire body margin or may be absent at the cephalic horns; antennae are four segmented; of the three pairs of spines or setae proximad of the antennae, the posterior ones are stout and short or slightly longer, the middle and anterior setae usually are elongate and rather slender or the middle pair may be short but more slender than the posterior pair. The distal rostral segment is two-thirds the length of second hind tarsus.

I have labeled a mounted adult aptera as lectotype of *Cerataphis palmae* (Ghesquière) and the remaining mounted and unmounted specimens paralectotpes. The slides are labelled "on *Raphia vinifera,* Kole (Sankuru), Congo belge, II-1928, J. Ghesquière." Three paralectotype slides are being kept for the US National Museum of Natural History (USNM) Collection, Beltsville, Maryland. The lectotype slide, 21 paralectotype slides and all unmounted material will be returned to Musée Royal de l'Afrique Centrale, Tervuren, Belgium.

Cerataphis variabilis Hille Ris Lambers
(Figs. 5, 6)

Regarding *C. variabilis,* Hille Ris Lambers (1953) wrote, "This insect would seem to be the common *Cerataphis* on *Cocos* and other Palms with a range extending from Africa to Fiji. The most conspicuous character is the enormous variability of the aleurodiform apterae, first mentioned by Van der Goot.

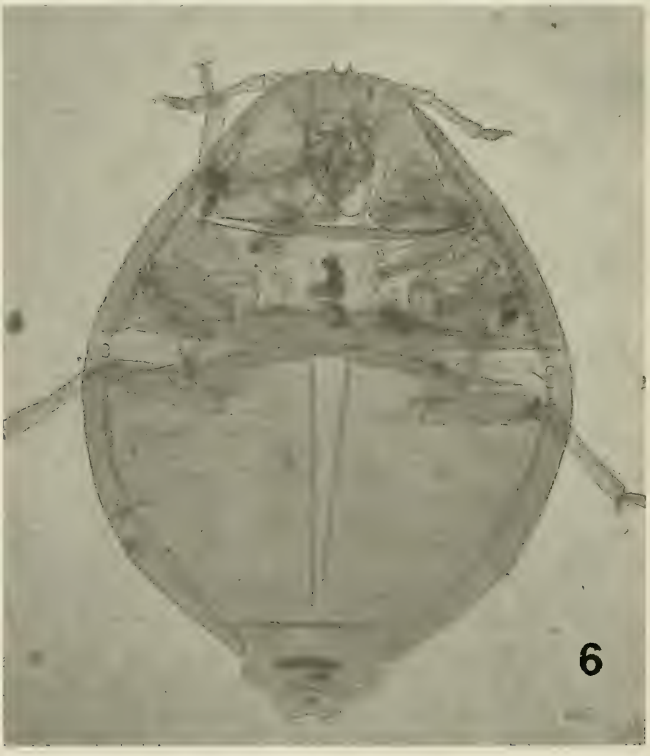
"The species differs from the two preceding ones [*C. lataniae* and *C. orchidearum*] by the presence of dagger-shaped hairs on stout bases on the underside of the head in apterae. Two extreme forms of apterae occur, one much like those of *C. orchidearum* (Westwood), and one more like a normal aphid, with wax-glands present on only the last abdominal tergite, the front with very small horns or only with 2–4 (more lateral) tubercles, each bearing a dagger-shaped, thorny spine."

Hille Ris Lambers (1953) added to the description in a key: "Front with or without horns, but, in addition to normal hairs, always with 1–3 pairs of short dagger- or club-shaped hairs on the underside near the antennal bases. At least one pair of these hairs placed on blunt tubercles."

Hille Ris Lambers did not designate a holotype or give detailed collection data but this information is available on slides. I have studied syntypes on two slides labeled "*Cerataphis variabilis* nov. spec. Java, Palmaceae, Bondowoso 300 m., 13-IX-1948, F. W. Rappard 62." One slide has four adult apterae and eight nymphs and is marked "Lectotype" with arrows pointing to a nearly normal specimen. The other slide has six adult apterae and five nymphs and is labeled "Cotypes, Det. D.H.R.L." I have also studied syntypes on a slide with three adult apterae labeled "*Cerataphis variabilis* nov. spec., N.Java, Pl. Palmaceae, Loc. Kalibendo, Date 29-XI-'48, Leg. F. W. Rappard 94." I have designated the specimen selected by Hille Ris Lambers as the lectotype of *C. variabilis* and the other adult apterae as paralectotypes.

Syntypes of *C. variabilis* are extremely variable as indicated by Hille Ris Lambers and by Noordam (1991) who redescribed syntypes as *C. palmae.*

In the lectotype of *C. variabilis* the an-



Figs. 5, 6. *Cerataphis variabilis.* 5, Paralectotype, head and prothorax: antennae 5 segmented; horns near rostrum, very small; a pair of slender setae laterad of horns, a pair of spines near, and a pair on body margin, each with tuberculate base; marginal wax glands absent except on tergum VIII. 6, Lectotype, body outline, structures nearly normal.

tennae are five segmented, the posterior characteristic spines are short and stout with strongly tuberculate bases while the middle and anterior setae are elongate and fairly slender with weakly tuberculate bases; the marginal wax glands are interrupted briefly on the abdomen. In the lectotype and syntypes I have examined, the cephalic horns are much smaller than in topotypes of *C. brasiliensis* and syntypes of *C. palmae*; they range downward in size from moderate to very small, are absent from one syntype, and in another syntype are near the rostrum with both horns small and one slender, curved and barely visible. The marginal wax glands form an almost complete band in some specimens, are interrupted or absent from sections of the margin, especially sections of the abdomen, and are totally lacking except for the eighth tergum in one specimen; the antennae are four segmented in two, and five segmented in 11 apterae; the three pairs of characteristic spines normally present proximad of the antennae exhibit different locations, shapes and sizes, with one pair on the margin of the head and two pairs just posterior to them in one specimen. The distal rostal segment is two-thirds the length of second hind tarsus.

These syntypes are diverse but I believe they are within the range of *brasiliensis,* and that *variabilis* is a synonym of the older name. *Cerataphis fransseni* (Hille Ris Lambers)

Hille Ris Lambers (1933) described *Astegopteryx fransseni* from *Styrax benzoin* Dryand, Buitenzorg, Java, indicating that the insects were from "a gall, which occurs in the axil of a leaf." He described alatae, apterae, first and second instars from the galls but wrote that he could not examine the embreyos within the body of the alata. He (1953) placed *fransseni* in *Cerataphis,* stating that living migrants from the gall of *A. fransseni* "showed that they produce typical *Cerataphis* larvae."

Eastop and Hille Ris Lambers (1976) listed *C. fransseni* as a valid species. Noordam (1991) examined types and additional specimens of *C. fransseni* from *Styrax,* described adult and the first instar larvae of alatae, and adult, first and two forms of second instar larvae of apterae. Although Noordam treated *C. fransseni* as a valid species, after discussing the similarity of nymphs of *fransseni* with those of *C. palmae,* he stated ". . . it is likely that *C. fransseni* is a synonym of *C. palmae.*"

Stern, Aoki and Kurosu (1995) studied the life cycle and general biology of *C. fransseni* and successfully transferred specimens from *Styrax* to palm where "1st instar nymphs were found feeding on the undersides of the leaves. . . . Several of these larvae became apterous adults with a typical *Cerataphis* morphology." These authors identified the specimens as *C. variabilis* and indicated that it and *C. palmae* were synonyms of *C. fransseni.* They examined paratypes of *C. variabilis* and data for some of them are the same as for paratypes I received from Hille Ris Lambers.

From available information it seems certain that *C. palmae, C. variabilis* and *C. fransseni* represent one species whose correct name, I believe, is *C. brasiliensis.* This name predates *fransseni* by 32 years.

Species of *Cerataphis* Found on Palms or Orchids

Cerataphis formosana Takahashi (1924) was described from *Cocos* sp., Kararu, Koshan, Formosa; later he (1931) included the name in a key. The species apparently has not been rediscovered. In 1975 Tao wrote me that he did not find types in collections in Taiwan and had not collected the species. Takahashi (1924, 1931) gave a distinguishing characteristic for the species, stating that the cephalic horns were "nearly fingerlike in shape,

Figs. 7, 8. *Cerataphis orchidearum.* 7, Head and prothorax: antennae 5 segmented; 3 pairs of slender setae proximad of antennae. 8, body outline.

with the apex rounded, almost as long as the 2nd antennal joint."

The other species on palms, *C. brasiliensis* and *C. lataniae,* and *C. orchidearum* on orchids, have a wide distribution on their respective hosts in greenhouses and possibly out-of-doors in tropical and subtropical regions.

Key to Adult Apterae of *Cerataphis* Species Living on Palms and Orchids

1. Cephalic horns finger-shaped, apices rounded. On *Cocos* sp., Taiwan . . . . . *formosana* Takahashi
– Cephalic horns usually somewhat triangular, apices usually pointed but sometimes blunt or rarely absent 2
2. With one, two or three pairs of short, stout

Figs. 9, 10. *Cerataphis lataniae.* 9, Head and prothorax: antennae 4 segmented; 3 pairs of slender setae proximad of antennae. 10, Body outline.

spines with strongly tuberculate bases proximad of antennae; characteristic spines and setae variable in size, shape and location, usually a posterior pair of stout spines on strongly tuberculate bases, a slender anterior pair of setae on flat or weakly tuberculate bases and a middle pair similar to either the posterior or anterior pairs; cephalic horns large, extending well beyond body margin, or small and extending cephalad, laterad or caudad or rarely absent; wax glands present around entire margin, absent at cephalic horns or elsewhere or rarely absent except on tergum VIII . . . . . .*brasiliensis* (Hempel)

– Without stout spines with strongly tuberculate bases but with three pairs of elongate, slender setae with flat or slightly raised bases proximad of antennae 3

3. Usually large, subcircular insects 1.50 mm long by 1.25 wide (range 1–1.75 long by 0.90–

1.50 wide); antennae usually 5 but sometimes 4 segmented; distal rostral segment about equal to second hind tarsus; cauda usually with 12–14 (range 10–17) setae; subgenital plate with 18–24 setae posteriorly; on orchids . . . . . *orchidearum* (Westwood)

– Usually small, ovoid insects 1 mm long by 0.70 wide (range 1–1.35 long by 0.70–1.10 wide); antennae usually 4 but sometimes 5 segmented; distal rostral segment two-thirds to three-fourths length of second hind tarsus; cauda usually with 8–10 (range 7–12) setae; subgenital plate with 7–14 setae posteriorly; on palms . . . . . *lataniae* (Boisduval)

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NEW MOTH FLIES (DIPTERA: PSYCHODIDAE) AND A KEY TO SPECIES FROM PUERTO RICO

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Abstract.—Collections of aquatic insects emerging from tropical rainforest mountain streams in Puerto Rico provided the following new species of Psychodidae (Diptera) which are described, figured, and compared with other Caribbean taxa: ***Trichomyia flinti, T. sattelmairi, T. buchholzi, Arisemus buzbyae, A. mariannae, A. waidei, Philosepedon mauroae, Psychoda puertoricana,*** and ***Psychoda juliae***. The period of emergence is indicated for six of these new species along with the flight period of *Maruina hirta* (Johannsen), and *Quatiella interdicta* (Quate). A key to the identification of these eleven species is included.

Key Words: Diptera, Psychodidae, new species, identification key, Puerto Rico, streams

The psychodids, often referred to as moth flies or sand flies (= Phlebotominae) are poorly known from the Caribbean area even though numerous papers exist (Vaillant and Botosaneanu (1970), Duckhouse (1974a, b), Johannsen (1938), Quate (1959), Satchell, (1955) and Wagner (1983, 1993). Long-term investigations in the tropics using emergence trap to collect adult aquatic insects are almost non-existent. In 1991–92 collections were made periodically on a weekly basis over almost 24 months (Wagner and Masteller 1993). They found only one out of eight species collected had been described. In this paper, nine new species from the El Verde and Bisley sites in Puerto Rico are described, along with detailed information on the flight period of the two known species from Puerto Rico, *Maruina hirta* (Johannsen) and *Quatiella interdicta* (Quate), (Quate 1955, Hogue 1973, Vaillant 1963, 1973, 1983, Wagner and Masteller, 1993).

The site and methods of collection were described in Masteller and Buzby (1993) for collections from Quebrada Prieta located at 390 m elevation at 18°N latitude with an average precipitation of 368 cm per year and stream temperatures ranging from 19° to 24°C. Shrimp are common in the streams; *Atya lanipes* Holthuis the prelevant species. The Quebrada Bisley site is described in Masteller and Flint (1993) and Scatena (1989). The Bisley site was at 270 m with a higher algal biomass and fewer shrimp than Q. Prieta, otherwise the two sites were similar.

Predominant insects in Q. Prieta were mayflies and caddisflies. The psychodids accounted for less than 2% of the Diptera collected. Ceratopogonidae and Chironomidae accounted for 49% and 35% respectively. Methods of preservation and preparation were as described in Wagner (1993).

Types and paratypes have been deposited at the Smithsonian Institution, National Museum of Natural History, Washington, D.C., the Puerto Rico Natural History Mu-

seum in San Jose, Puerto Rico, and in the author's collections.

Key to Male Psychodidae of Puerto Rico

1. Wing with 9 longitudinal veins, i.e. only a single vein between the forks R_{2+3} and M_{1+2}, smaller than 2 mm in size; Subfamily Trichomyiinae, genus *Trichomyia* Haliday (3 spp.) 2
– Wing with 10 longitudinal veins, i.e. two veins between the forks R_{2+3} and M_{1+2}, body size and wing length more than 2 mm; Subfamily Psychodinae 4
2. Palpus 4-segemented, tergite 7 without long black setae, basistyles cylindrical, dististyles shorter than basistyle with blunt tip . . . . . *Trichomyia buchholzi,* n. sp.
– Palpus 3-segmented, tergite 7 with long black setae or dististyles missing 3
3. Male genitalia without dististyles, aedeagus with a pair of sickle-shaped parameres . . . . . *Trichomyia flinti,* n. sp.
– Tergite 7 with 2 or 3 elongate black setae; basistyles each with 2 dorsal appendages, one medial and one distal longer than dististyles, dististyles with 2 sharp tips . . . . . *Trichomyia sattelmairi,* n. sp.
4. Flagellomeres with Y-shaped ascoids, distal segments reduced in size, pale taxa with wings held roof-shaped over the abdomen, male cercopodia with one tenaculum 5
– Distal flagellomeres not reduced in size, ascoids elongate, finger-shaped, wings held horizontally over the abdomen, male cercopida with more than one tenaculum 8
5. Male genitalia symmetric 6
– Male genitalia asymetric 7
6. Male cercopodia with 2 tenacula . . . . . *Philosepedon mauroae,* n. sp.
– Male cercopodia with 1 tenaculum . . . . . *Quatiella interdicta* (Dyar)
7. Basistyle short quadrate, dististyles elongate with single tip, aedeagus with sickle shaped thin paramere . . . *Psychoda puertoricana,* n. sp.
– Basistyles elongate, tip of dististyles bifurcate, aedeagus broad, with a strongly arched thin paramere . . . . . *Psychoda juliae,* n. sp.
8. Wing lanceolate, number of veins reduced . . . . . *Maruina hirta* (Johannsen)
– Wing oval, with 10 longitudinal veins, and dark spots at vein tips of wing margin 9
9. Distal flagellomeres reduced in size 10
– Distal flagellomeres not reduced in size, tips of all veins with small spots, dististyles S-shaped, ventral aedeagus sclerite thin . . . . . *Arisemus waidei,* n. sp.
10. Tips of CuA_1 and CuA_2 with large black spots, sector radii branched into R_2 and R_{3+4}, basistyles fused medially, dististyles straight with bifurcate tip . . . . *Arisemus buzbyae,* n. sp.
– Tip of CuA_1 with a small black spot and CuA_2 with a large black spot, sector radii branched into R_{2+3} and R_4, dististyles straight with blunt tip, both aedeagus sclerites broad . . . . . *Arisemus mariannae,* n. sp.

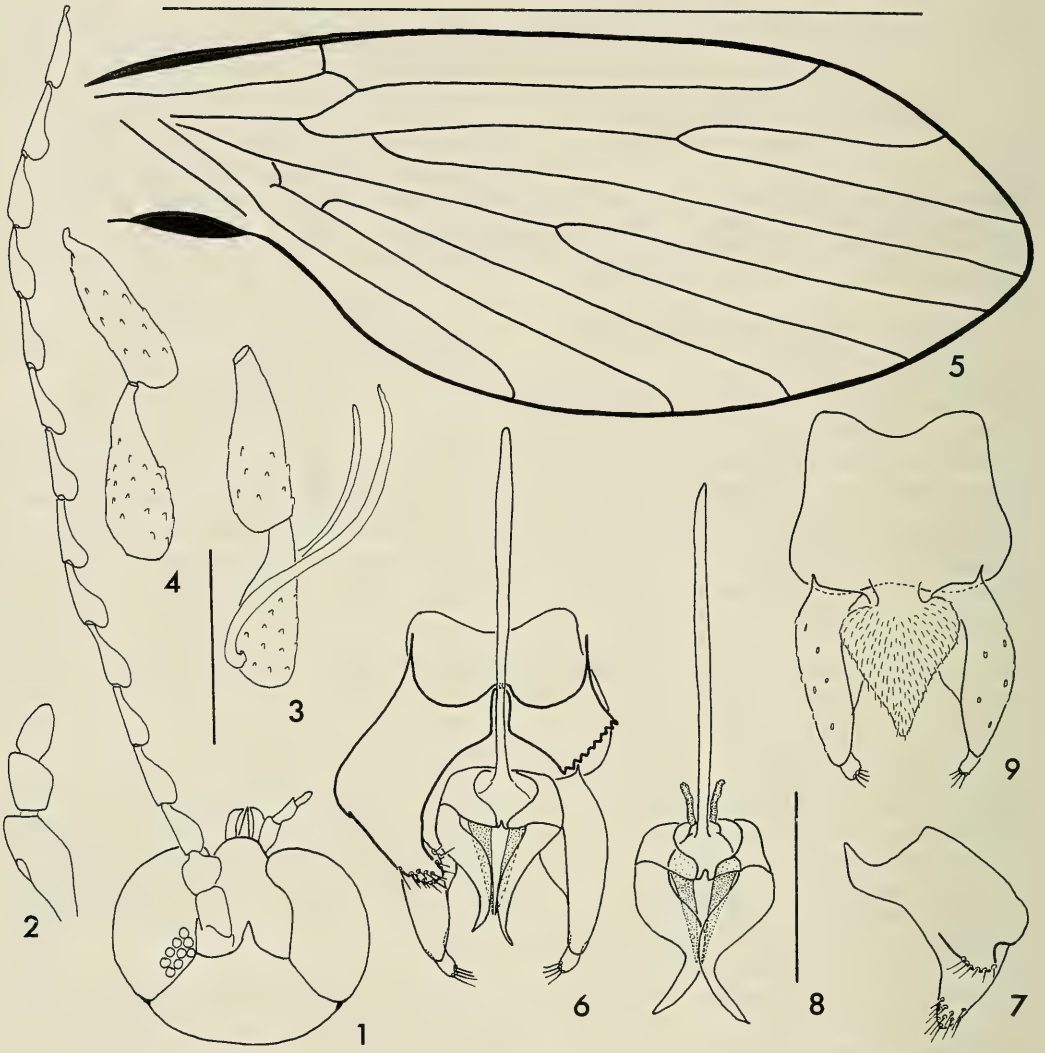
Psychodidae: Trichomyiinae

Trichomyia flinti Wagner and Masteller, New Species
(Figs. 1–9)

Description.—*Head* (Fig. 1) slightly wider than long, eyes laterally without eye bridge, vertex with medial tip. Antenna 15-segmented, scape cylindrical, 1.2 times longer than wide, pedicel spherical, flagellomere (Fig. 3) bottle-shaped, each with pair of simple, elongate ascoids, nearly twice as long as an antennal segment. Distal segment insertion very asymmetric (Fig. 4). Relative length of antennal segments: 25-25-30-32-32-32-32-33-34-33-33-33-34-34-35. Maxillary palpus (Fig. 2) 3-segmented, basal segment with shallow circular depression. Relative length ratio of maxillary palpus segments: 20-10-9.

Wing (Fig. 5), length 1.3 mm. No vein markedly widened or sclerotized. Sc ends in costa and at its tip is a crossvein towards R_1. No R-M crossvein. A short crossvein M_{1+2}–M_{3+4}, and a long cubital vein. No veins markedly widened.

Male genitalia (Fig. 6) unusually complicated for this genus. Aedeagus (Fig. 8) situated ventrally, with elongate basal apodeme, and two pairs of distal sclerites, ventral pair of S-shaped and dorsal pair of straight triangular sclerites. At basal end of sclerite, a pair of ducti ejaculatorii opens into distal part of aedeagus. Styles (Fig. 7) markedly bent, situated ventrally, no distinction into basi- and dististyles, or dististyles reduced. Tip blunt, bipartite, covered with several short setae. Basistyles joined medially by thin bridge. Basal



Figs. 1–9. *Trichomyia flinti*. 1, Head. 2, Palpus. 3, Flagellomere with ascoids. 4, Distal flagellomeres. 5, Wing. 6, Genitalia, ventral view. 7, Basistyle, dorsal view. 8, Aedeagus. 9, 9th and 10th tergites and cerci, ventral view. [Scale 1.0 mm (5), other Figs. 0.1 mm]

part of aedeagus apodeme kept in position by U-shaped sclerite. Ninth tergite almost quadrate, 10th tergite elongate, heart shaped and setose (Fig. 9). Cerci in vertical plane, distally with short appendage and 4 distal setae in position where Psychodinae tenacula situated.

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** El Verde, Quebrada Prieta, Malaise trap, 370m NN, 6–10 February 1990 leg. O.S. Flint.

Etymology.—This rare species is dedicated to the collector O. S. Flint, Jr., a renowned caddisfly researcher who first collected this species in a Malaise trap at El Verde, Puerto Rico.

Remarks.—This new species is a member of a species group including the other small *Trichomyia* species of the Caribbean and the Nearctic species, *Trichomyia wirthi* Quate. *Trichomyia flinti* is one of the most apomorphic species of this group, based on the fused styles (or reduced dististyles) and the two pairs of distal aedeagal sclerites,

Figs. 10–17. *Trichomyia sattelmairi.* 10, Head. 11, Flagellomere with ascoids. 12, Palpus. 13, Wing. 14, Genitalia, ventral view. 15, Basistyle, dorsal view. 16, 9th tergite and cerci, dorsal view. 17, 9th and 10th tergites and cerci, ventral view. [Scale 1.0 mm (13), other Figs. 0.1 mm]

which are unique to this entire species group.

Trichomyia satterlmairi Wagner and Masteller, New Species
(Figs. 10–17)

Description.—*Head* (Fig. 10) with large lateral compound eyes, hind margin of eyes rear margin of head. Vertex with thin frontomedial tip. No definite rows of postocular bristles. Antenna 15-segmented: Scape and pedicel approximately cylindrical, flagellomere elongate, bottle shaped each with pair of basally inserted simple ascoids, slightly longer than a segment (Fig. 11). Relative length ratio of antennal segments: 22-19-28-30-30-30-30-30-30-30-30-30-30-31. Maxillary palpus (Fig. 12) 3-segmented, basal segments with circular shallow depression: relative length ratio of maxillary palpus segments: 17-12-12.

Wing (Fig. 13) translucent, length 1.2 mm. Sc ends in costa, a crossvein towards R_1–R_{4+5} simple, basal part of R_1 and M_{3+4}

broad and with a heavily sclerotized peduncle and a crossvein at R_5/M_{1+2}. Thorax and legs without specific features.

Male genitalia (Fig. 14) complicated. Basistyles (Fig. 15) quadrate in ventral view, 2 dorsal appendages, basal shorter, angular, distal elongate, straight and longer than corpus of basistyle. Dististyle with 2 tips, triangular, same length as basistyle. Ninth tergite rectangular, basal side sclerotized (Fig. 16). Cerci in vertical position, approximately triangular in ventral view, without hairs or setae. Tenth tergite triangular, with setose elongate basal portion (Fig. 17). Aedeagus with thin elongate basal sclerite, distally ending with a pair of lateral, slightly curved tips, with a blunt end between. Testes and ducti ejaculatorii clearly visible, both ducti join into single ductus. Testes spherical; located in abdominal segment 5; ducti not longer than testes diameter. More parts of abdomen belong to the genitalia in the widest sense. Dorsally in segment 5 lies a thin sclerite, probably reduced tergite 6. Next (where ducti join) in segment 7, with a pair of distal propulsion, each with 3–4 elongate setae. Sclerites of tergite 8 completely reduced. These assumptions are made from observations of other very small Holarctic Trichomyiidae where the reduction of several sclerites or entire segments seems to be quite common (Wagner 1982).

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** El Verde, Quebrada Prieta, 370 m a.s.l., emergence trap, 24 June 1991. PARATYPES: 7♂-6♀ from same location as holotype; El Verde, Q. Prieta emergence trap, 6♂-2♀.

Etymology.—This species is dedicated to Ernst Sattelmeier, Schlitz, Germany.

Emergence.—This species was less abundant than *T. buchholzi.* Emergence periods were from February–April and June–August.

Remarks.—This new species is a close relative of *T. flinti.* It is most closely related to *Trichomyia botosaneanui* Wagner, from Martinique. In both taxa sclerites of the second abdominal segment are fused (or one abdominal segment reduced). In place of a pair of long black spines, as in *T. botosaneanui,* this new species bears some black setae on segment 7 and the dististyles are reduced.

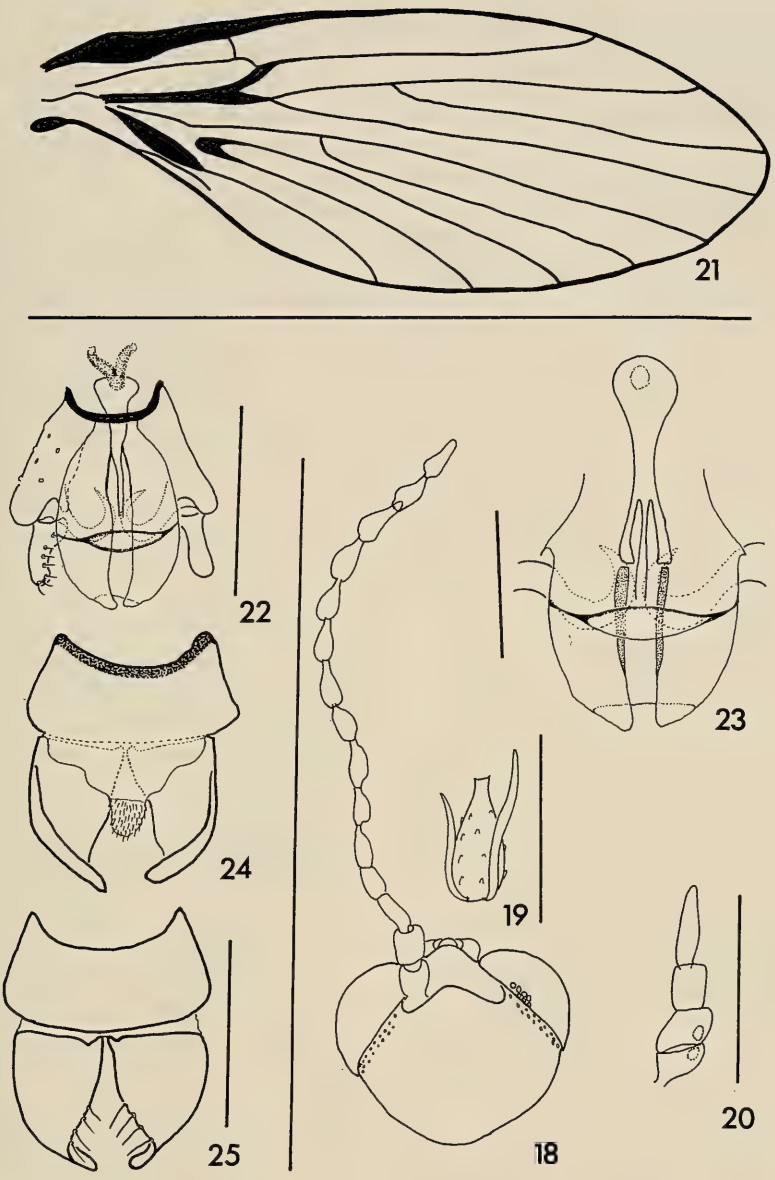
Trichomyia buchholzi Wagner and Masteller, New Species

(Figs. 18–25)

Description.—*Head* (Fig. 18) with circular eyes. Distance between eyes at front side of head 12 facet diameters. Two rows postocular bristles. Antenna 15-segmented, inserted close together on front side of head. Scape and pedicel cylindrical of similar length. Flagellomere bottle shaped, each with two simple ascoids of unequal length (Fig. 19), inner longer than lateral and longer than flagellar segment. Relative length of antennal segments: 7-7-9-6-8-7-8-7-8-8-8-8-8-11. Maxillary palpus (Fig. 20) 4-segmented, both basal segments each with a circular depression. Relative length of maxillary palpus segments: 7-8-9-16. Basal segment short and stout. Third segment, cylindric; distal segment elongate, annulated.

Wing (Fig. 21), length 1.0 mm, without neala. Costa basally swollen, Sc ends in costa at tip with cross vein towards R_1. Base of radius and sector radius broad, sclerotized, as well as base of M_3/CuA_1 and CuA_2.

Male genitalia simple. (Figs. 22–25) Basistyles cylindrical 2.5 times longer than wide. Distally dorsal sides with elongate, hook-shaped inner appendages, almost meeting medially and appear to be in contact with two thin aedeagal sclerites. Dististyles 0.6 times length of basistyles, triangular with blunt tips, slightly bent. Ninth tergite wider than long, rectangular, lateral portions rolled up. Basal margin more strongly sclerotized than distal margin. Tenth tergite slightly sclerotized, distal portion conical, setose. Cerci triangular in dorsal and ventral view, well sclerotized, few setae along inner dorsal margins; rolled up



Figs. 18–25. *Trichomyia buchholzi.* 18, Head. 19, Flagellomere with ascoids. 20, Palpus. 21, Wing. 22, Aedeagus and styles, ventral view. 23, Aedeagus and cross sclerite, ventral view. 24, 9th and 10th tergites and cerci, ventral view. 25, 9th and 10th tergite and cerci, dorsal view. [Scale 1.0 mm (21), other Figs. 0.1 mm]

laterally forming a tube. Aedeagus situated ventral of styles, basal racket with 3 distal prolongations. Lateral sclerite articulated with inner sides of a slightly sclerotized cylindric structure, open ventrally and distally, with single gonoporus. Centrally lies an additional cross sclerite, keeping the lateral portions together. Basal portion of racket with short circular opening, before the two sclerotized sperm ducts join into one; distal portion invisible.

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** El Verde, Quebrada Prieta, 370 m a.s.l., emergence trap, 14 June 1991, ALLOTYPE ♀, same locality as holotype, June 1992. PARATYPES: 3♂-17♀ from

same location as holotype; El Verde, Q. Prieta emergence trap, 7♂-6♀; El Verde, Q. Prieta emergence trap, 28 June 1992, 1♀; El Verde, Q. Prieta emergence trap, 15 January, 1992, 1♂-1♀.

Etymology.—This species is dedicated to Helmut Buchholz, Schlitz, Germany.

Emergence.—Specimens of this taxon are numerous along the stream in January and from March to August.

Remarks.—The closest relative of this species appears to be *T. wirthi* Quate, from Florida (*holotype*) and the entire southeastern part of the U.S.A. Both species are distinguished by the shape of the dististyles, those of *T. wirthi* being elongate and approximately as long as the basistyles and by the different shape of the aedeagal sheath, tergite 9 and cerci.

Relations of Puerto Rican *Trichomyia* Species

The three new species described above belong to a group of species of very small Trichomyiinae together with *T. botosaneanui* Wagner from Martinique, *T. masneri* Wagner and *T. rawlinsi* Wagner from the Dominican Republic, and *T. wirthi* from Florida and Georgia in Southeastern United States (Wagner, 1980). Compared with other taxa of the subfamily they might be treated as a separate genus. Reduction of the distal part of the abdomen occurs frequently. Some of the tergites (5–8) are heavily reduced and it is often difficult to interpret to which segment a sclerotized plate belongs. Even stronger reductions occur in the genitalia, which often are without definite gonostyles. In some taxa elongate sclerites of segment 7 and/or 8 may function as part of the genitalia.

Psychodidae: Psychodinae

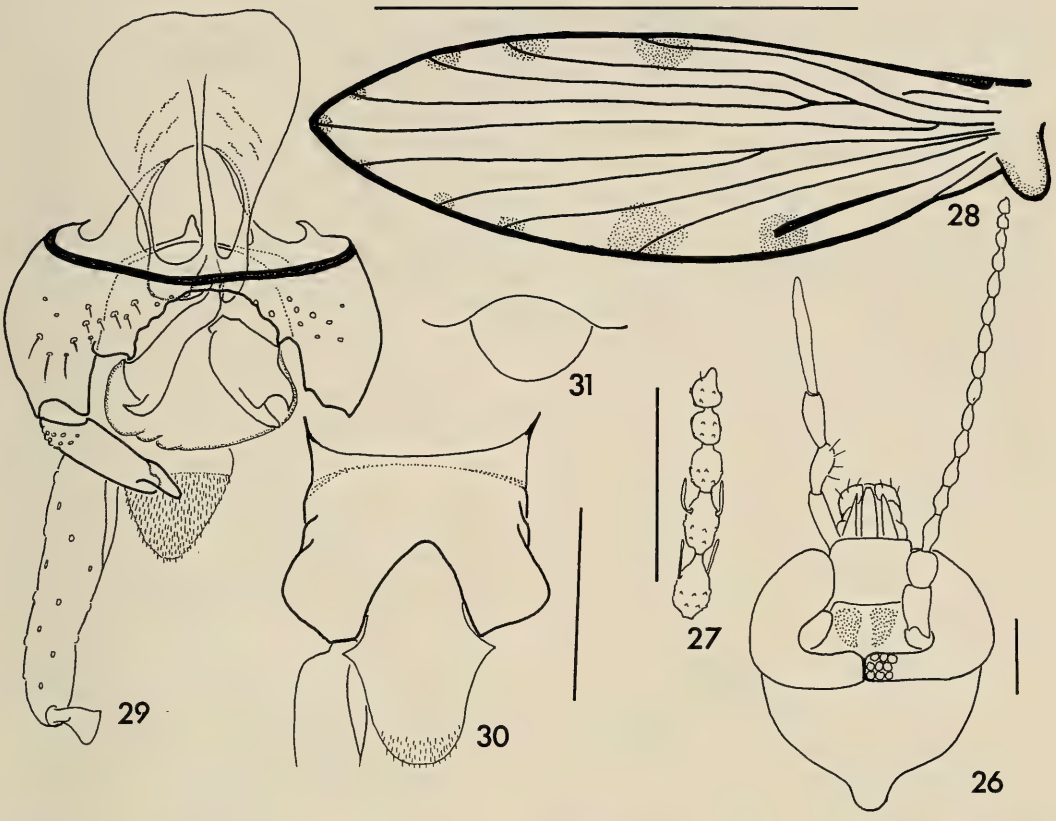
Arisemus buzbyae Wagner and Masteller, New Species

(Figs. 26–31)

Description.—*Head* (Fig. 26) slightly longer than wide with distinct basal projection, portion behind eyes as long as front part. Eye reniform, contiguous over 3 facet diameters. Antenna 16-segmented with distal segments reduced in size (Fig. 27). Scape cylindrical, 1.5 times longer than wide, pedicel spherical, flagellomeres bottle-shaped, segments 6–13 each with pair of simple short ascoids. Relative length of antennal segments: 24-18-18-15-15-15-14-14-14-14-14-13-12-7-6-9. Relative length of maxillary palpus segments: 27-23-30-52.

Wing (Fig. 28) length 1.4 mm, approximately 3 times longer than greatest width. Sc curved towards R_1. Forking $R_2/R_3/R_4$ unusual. R_2 is a vein, with another vein R_{3+4} possessing short stem before fork R_3/R_4. Cubital vein stout, distally not reaching costa. Tips of each vein with circular brown spot. Size of spots increases toward wing base, largest spots at R_2, M_4 and Cu. Thorax and legs without specific features.

Male genitalia uncomplicated, (Fig. 29) asymmetric. Basistyles fused medially on dorsal and ventral side forming a ring. Sternal band, found in most palearctic species not developed. Dorsal fusion of basistyles thin with short spine pointing basally. Basistyles basally wide, narrower distally. Medially fused by an irregular shaped sclerite, small prolongation on both sides, on which parts of aedeagus are articulated. Dististyles straight, as long as basistyles, tip bipartite, ventral tip shorter than dorsal. Aedeagus asymmetrical, distal portion with one short and two elongate sclerites, articulated with a hook of a basistyle. The elongate sclerite with a single tip and the short sclerite with two tips; all covered by a thin sclerotized sheath. Basal part of aedeagus heavily sclerotized, basally semicircular, dorsoventrally flattened sclerite, distal thinner part with an oval opening. A medial thin sclerite lies ventrally connecting basal and distal areas of the sclerite, articulated to distal movable parts of aedeagus. Ninth tergite quadrate, with deep triangular distal incision for 10th tergite and elongate subgenital plate. Cercopodia almost straight, with single large distal tenaculum (Figs. 30, 31).



Figs. 26–31. *Arisemus buzbyae.* 26, Head. 27, Distal flagellomeres. 28, Wing. 29, Genitalia, ventral view. 30, 9th and 10th tergites and cercopodia. 31, Anal valve. [Scale 1.0 mm (28), other Figs. 0.1 mm]

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** tributary Mamayes, Bisley stream, Luquillo Experimental Forest, emergence trap, 4 November, 1991 leg. Buzby & Masteller. PARATYPES: 6♀ El Verde, Q. Prieta 1989, along with 3♂-4♀; El Verde, Q. Prieta emergence trap, 1♂-2♀; El Verde, Q. Prieta emergence trap, February 1992, 7♂.

Emergence.—*Arisemus buzbyae* was rare among the Psychodidae of Quebrada Prieta with adults collected during March and May.

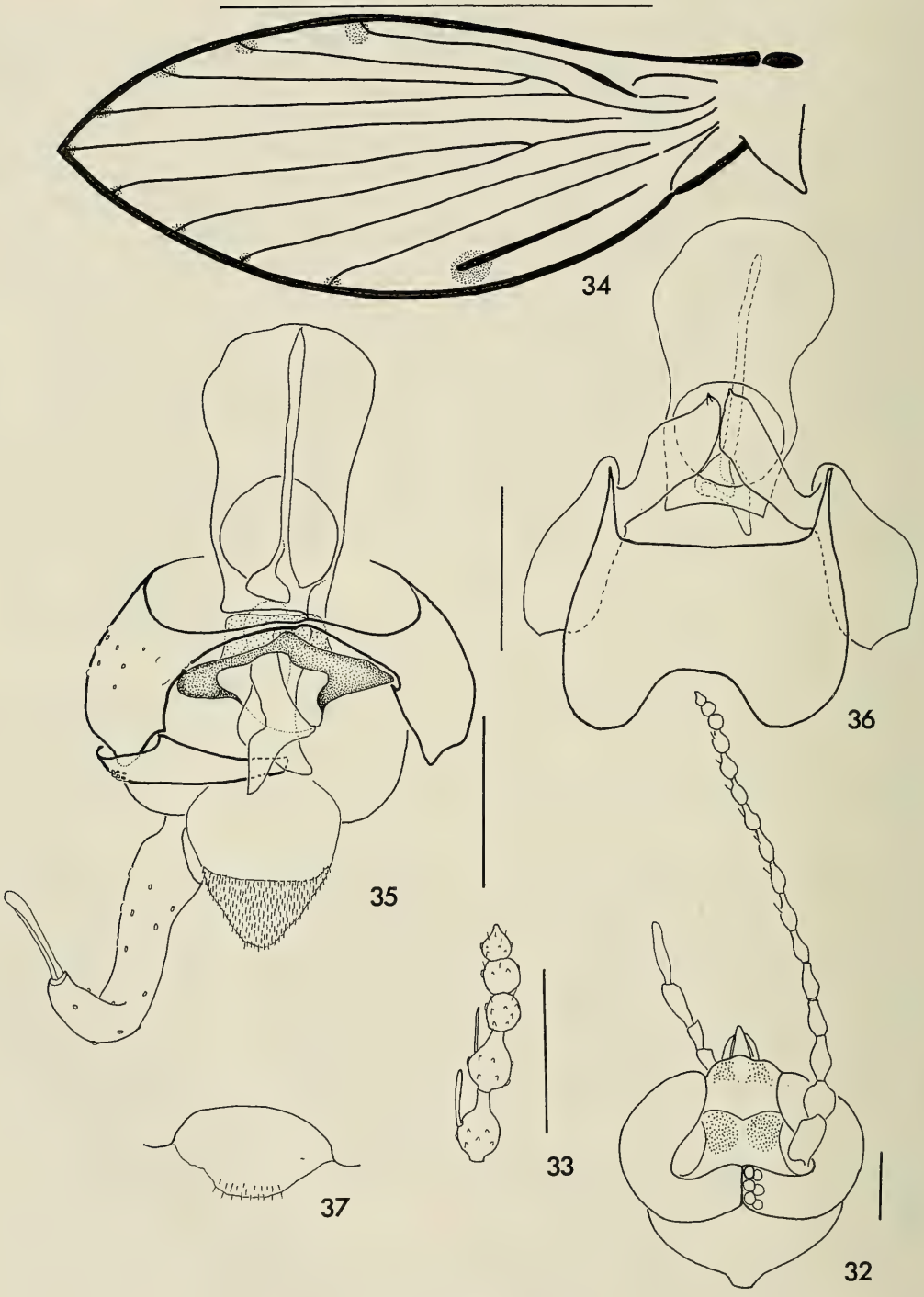
Etymology.—This species is dedicated to Karen Buzby, who diligently emptied the traps for two years while doing research in Puerto Rico.

Remarks.—This new taxon, *Arisemus,* of the Caribbean area is, related to the next taxon and *Arisemus boxi* Satchell. It is distinguished from *Arisemus mariannae* Wagner and Masteller by the elongate wing and the almost straight dististyle with a bifurcate tip. The *type* species, *Arisemus boxi* Satchell, from St. Lucia and (*holotype*) from Martinique (Wagner 1993), has a similar color pattern of the wing. Because of the broad setae of the pedicel, it probably belongs to another species group.

Arisemus mariannae Wagner and Masteller, New Species

(Figs. 32–37)

Description.—*Head* (Fig. 32) circular, with small postocular projection. Eye reniform, contiguous over 3 facet diameters. Antenna 16-segmented, distal 3 segments reduced in size (Fig. 33). Scape cylindrical, 1.5 times longer than wide, scape spherical, flagellomeres bottle shaped. Relative length



Figs. 32–37. *Arisemus mariannae*. 32, Head. 33, Distal flagellomeres. 34, Wing. 35, Genitalia, ventral view. 36, 9th tergite, basistyles with dorsal apodemes and basal aedeagus sclerite. 37, Anal valve. [Scale 1.0 mm (34), other Figs. 0.1 mm]

of antennal segments: 30-20-27-22-21-20-20-18-18-17-15-15-14-8-8-8. Relative length of maxillary palpus segments: 14-17-23-35.

Wing (Fig. 34) twice as long as its greatest width. Sc short, its tip recurved towards R_1 and slightly wider in this area. Forks R_{2+3}/R_4 and R_2/R_3 close together in basal half of wing as fork M_1/M_2. CuA_2 very strong, not reaching costa. Small brownish spot at tip of each vein; spot size increasing towards wing base. Wing length 1.6 mm. No specific features on thorax and legs.

Male genitalia (Fig. 35) with asymmetric aedeagus. Ninth tergite wider than long with pair of front lateral projections, (articulation with basistyles) and medial semicircular incision distally for the conical setose subgenital plate. Cercopodia strongly curved with one strong tenaculum. No sternal band. Basistyles fused medially via thin bridge ventrally, their dorsal apodemes elongate basally, close together medially but unfused (Fig. 36). Dististyles as long as basistyles, straight with blunt tip. Aedeagus with basal, dorsoventrally flattened sclerite, circular incision distally. One side is articulated with distal sclerites of aedeagus. Ventrally, a thin medial, straight sclerite, distally broadened articulated to the distal aedeagal sclerites. Both basal aedeagal sclerites unfused. Ventral sclerite comparatively narrow, with longer and shorter lateral tip, dorsal broader with less pronounced lateral tip. Both sclerites articulate with the basistyles which are surrounded by heavily sclerotized medially open sclerite.

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** tributary Mamayes, Bisley stream, Luquillo Experimental Forest, emergence trap, 2 Feb. 1991 leg. Masteller. PARATYPES: 3♂-3♀ from the same locality, 1989–1992.

Etymology.—The species is dedicated to Marianna Masteller, wife of ECM.

Emergence.—This species was a rare Psychodid in the emergence traps, collected exclusively in January and May.

Remarks: This is another new *Arisemus* taxon of the Caribbean region, related to the taxon described above. The shape of styles, aedeagus and wing distinguish it from relatives, *A. boxi* and *A. buzbyae.*

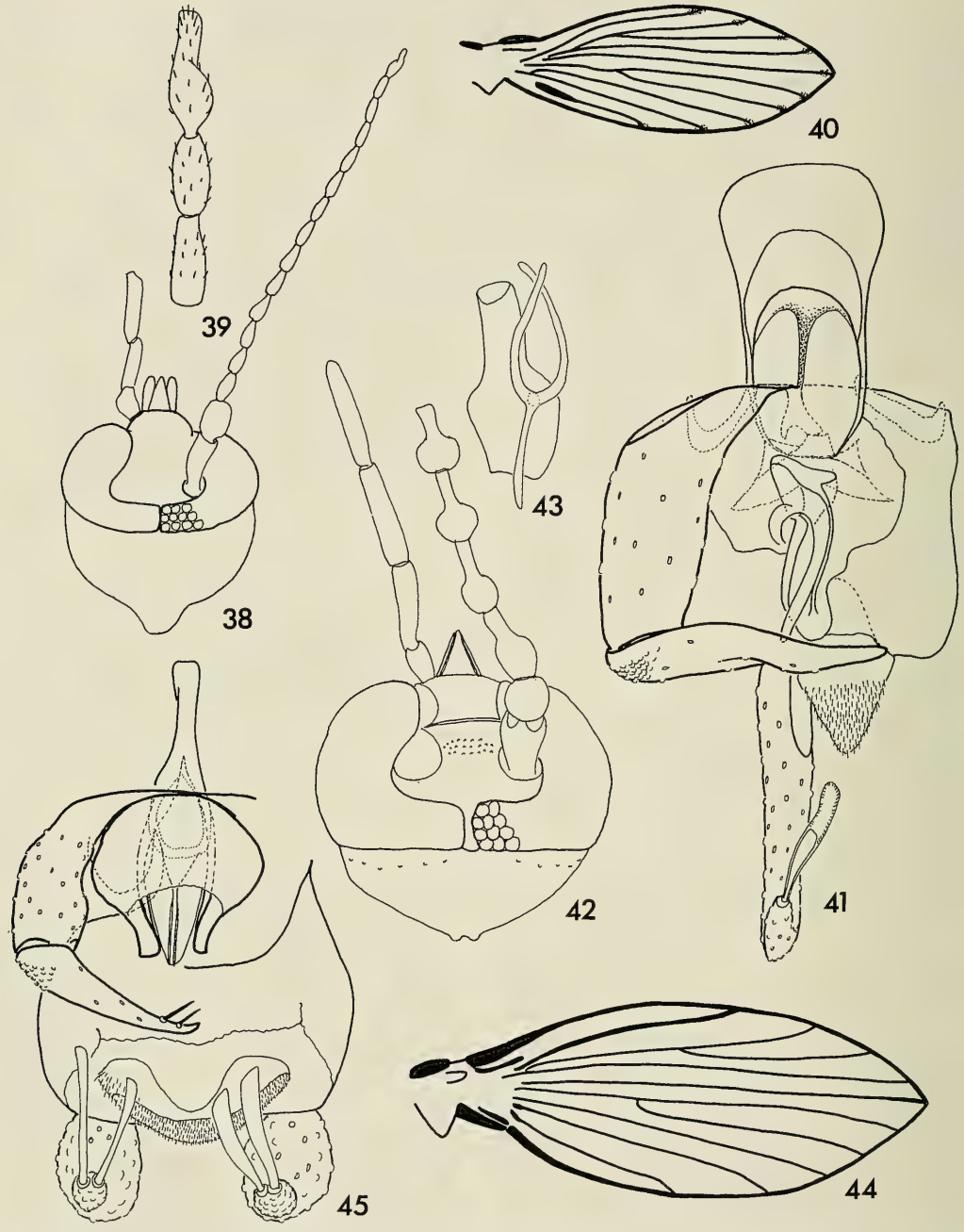
Arisemus waidei Wagner and Masteller, New Species
(Figs. 38–41)

Description.—*Head* ovoid (Fig. 38), wide postocular portion. Eye reniform, eye bridge contiguous over 3 facet diameters. Antenna 16-segmented, pedicel cylindrical, 2.5 times longer than wide, scape elongate, flagellomeres barrel shaped, distal segments not reduced, terminal segment longer than penultimate (Fig. 39). Relative length of antennal segments: 28-22-16-15-15-15-15-16-15-14-14-14-12-12-11-16. Relative length of maxillary palpus segments: 15-22-32-distal segment missing.

Wing twice as long as width (Fig. 40). Sc short and straight, R_1 elongate. Forks R_{2+3}/R_4 and R_2/R_3 close together in basal half of wing, forks R_2/R_3 at same level as fork M_1/M_2. CuA_2 very strong basally. Tips of longitudinal veins with brownish spots. Wing length 1.6 mm. No other specific features on thorax and legs.

Male genitalia uncomplicated (Fig. 41) with asymmetric aedeagus. Ninth tergite almost quadrate, 10th tergite conical, setose. Cercopodia strongly curved with one tenaculum. No sternal band. Basistyles almost straight, twice as long as wide; meeting at inner tips medially, dorsal apodemes sickle-shaped linked to basal part of aedeagus apodeme. Dististyles longer than basistyles, slightly S-shaped with blunt tip. Aedeagus with basal, dorsoventrally flattened sclerite, and distal oval incision. Articulated on both sides of basistyles with sickle-shaped sclerites. Distal part covered by sclerotized sheath, with broad, thin sclerite below, tips at almost same level.

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** El Verde, Quebrada Prieta, emergence trap, 2 March, 1992 leg. Buzby & Masteller. PARATYPES: 2♂-4♀ from same locality along with 25♂-25♀; El Verde, Q. Prieta emergence trap, 1989, 1♂; El



Figs. 38–45. *Arisemus waidei.* 38, Head. 39, Distal flagellomeres. 40, Wing. 41, Genitalia, ventral view. *Philosepedon mauroae.* 42, Head. 43, 7th flagellomere. 44, Wing. 45, Genitalia, ventral view.

Verde, Quebrada Sonadora, light trap, 14 February, 1989, 2♀; Bisley, tributary of Mamayes, Luquillo Experimental Forest, 2 April, 1991, 2♀; Cocoa Falls, El Yungue, 7 June, 1991, 1♂.

Etymology.—This species is dedicated to Robert B. Waide, director of the El Verde Field Station, Puerto Rico who has been a strong advocate of our stream research, providing numerous forms of assistance.

Emergence.—Numerous specimens were caught in the emergence traps, with abundance markedly greater from the Bisley stream. Emergence was observed from January–March, and May, August.

Remarks: Relations of *A. waidei* to other taxa remain unclear at this time, due to the different shape of the flagellomeres and the construction of the aedeagus. Its placement in this genus is provisional.

Philosepedon mauroae Wagner and Masteller, New Species
(Figs. 42–45)

Description.—*Head* (Fig. 42) circular, with medium sized postocular portion. Eye reniform, divided by 1 facet diameter, interocular suture thin, slightly bent. Eye with one row of postocular bristles. Antenna with short cylindrical scape, as long as wide, pedicel globular, flagellomeres bottle shaped, each with pair of Y-shaped ascoids (Fig. 43). Relative length of antennal segments: 12-9-15-15-14- distal segments missing. Relative length of maxillary palpus segments: 7-17-21-23.

Wing (Fig. 44) more than twice as long as wide. Sc short and straight. R_1 elongate, stronger than other longitudinal veins. Area of wing membrane in front of and parallel to R_1 opaque. Wing length 2.1 mm. Thorax and legs without specific features.

Male genitalia simple (Fig. 45) with symmetric aedeagus. Ninth tergite almost quadrate, rounded edges, deep basal incision, 10th tergite bilobed, distally setose. Cercopodia strongly curved with two tenacula. No sternal band. Basistyles fused medially at inner tips, slightly bent, twice as long as distal width. Dorsal apodemes sickle-shaped, linked with basal part of aedeagus apodeme. Dististyles longer than basistyles, slightly curved with blunt tip. Two prominent setae near the tip. Aedeagus with racket-shaped apodeme. Two elongate lateral sclerites joined to posteroventral plate, which has two lateral prolongations and deep distal incision. In the incision, the distal portion of inner blade-shaped sclerites of aedeagus are visible.

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** El Verde, Quebrada Prieta, emergence trap, 30 June, 1992 leg. Buzby & Masteller.

Etymology.—This species is dedicated to Mrs. Kathy Mauro, who meticulously typed, proofed manuscripts and offered assistance over the past 10 years.

Emergence.—*Philosepedon mauroae* was quite rare in the emergence traps. We believe its habitat is shells of dead snails residing in the stream.

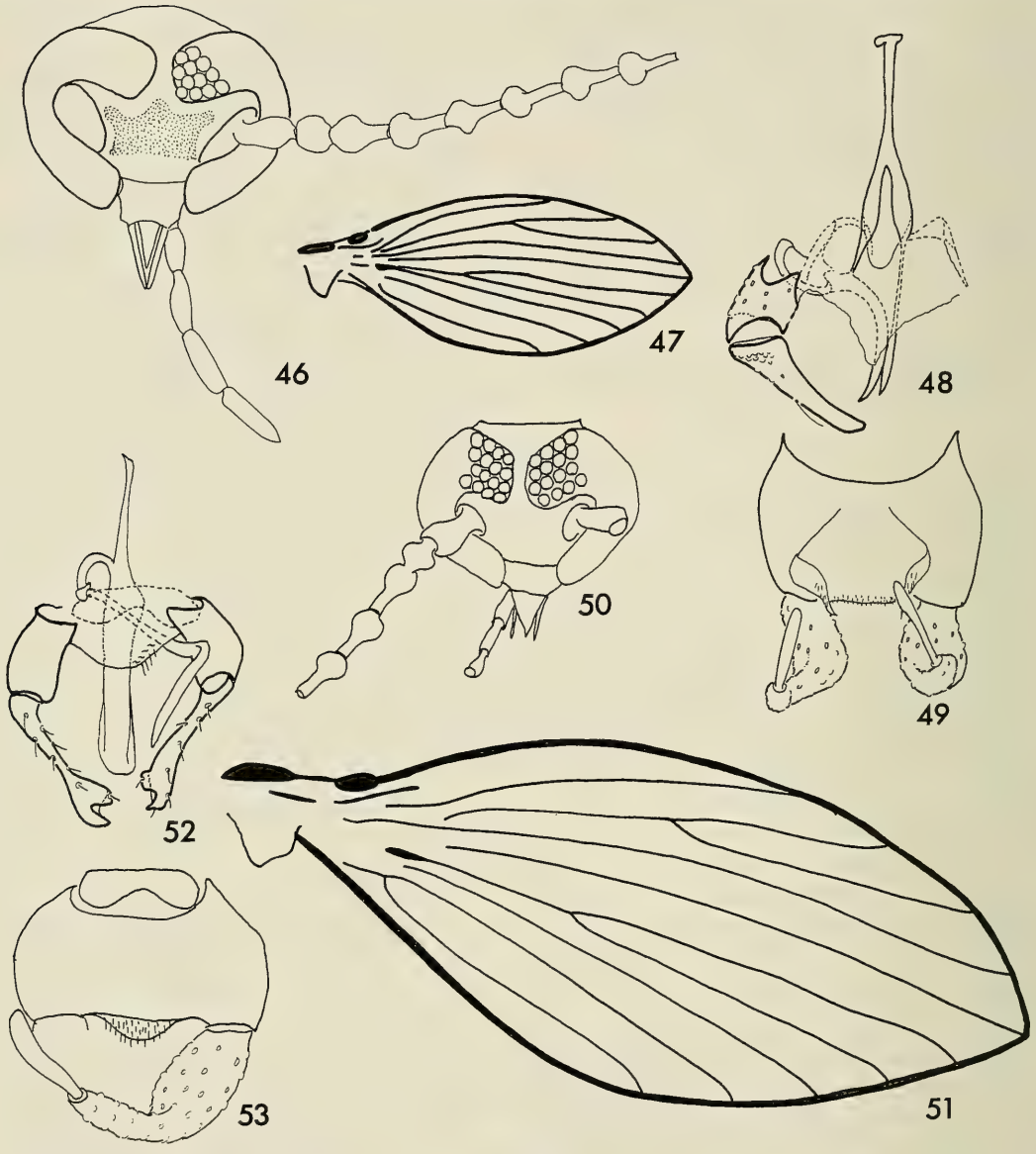
Remarks: The paired tenacula, shape of the flagellomeres and ascoids provide evidence for this species belonging to the genus *Philosepdon* Meigen, along with its viviparous (larviparous) nature. Larvae of palearctic taxa occur exclusively in dead snails, and larvae of the Nearctic *Philosepdon quatei* Vaillant have also been reared from dead gastropods [*Mesodon chiloweensis* (Lewis)] (Vaillant 1973). Two Nearctic taxa, *Philosepdon helicis* (Dyar) and *Philosepdon opposita* (Banks), seem to be less closely related, due to shape and construction of the genitalia.

Psychoda puertoricana Wagner and Masteller, New Species
(Figs. 46–49)

Description.—*Head* (Fig. 46) oval, with small postocular area. Eye reniform, eye bridge with 4 rows of facets, smallest interocular distance 1.5 facet diameters, no interocular suture. Pedicel cylindrical, 2 times longer than wide, 1.5 times longer than globular scape, flagellomeres bottle shaped with Y-shaped ascoids. Relative length, antennal segments: 12-7-12-11-12-12-12-11-, distal segments missing. Relative length maxillary palpus segments: 16-24-26-30.

Wing (Fig. 47) approximately twice as long as width, venation typical for the genus. Wing length 1.6 mm. Thorax and legs without specific features.

Male genitalia uncomplicated (Fig. 48),



Figs. 46–53. *Psychoda puertoricana.* 46, Head. 47, Wing. 48, Styles and aedeagus, ventral view. 49, 9th tergite and cercopodia, ventral view. *Psychoda juliae.* 50, Head. 51, Wing. 52, Styles and aedeagus, ventral view. 53, 9th tergite and cercopodium, ventral view.

asymmetric aedeagus. Ninth tergite rectangular, wider than long, 10th tergite distally setose (Fig. 49). Cercopodia strongly curved with one tenaculum. No sternal band. Basistyle short, almost as long as wide and half length of dististyle, apparently not linked medially, dorsal apodemes linked to basal part of aedeagus apodeme. Dististyles longer than basistyles, straight with blunt tip. Aedeagus with Y-shaped, dorsoventrally flattened basal sclerite, articulated on both sides with dorsal sclerites of basistyles, additionally on one side with sickle-shaped aedeagus sclerite. Distal part of aedeagus covered by slightly sclerotized sheath, with both aedeagus sclerites below,

one straight the other sickle-shaped, tips at the same level.

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** El Verde, Quebrada Prieta, emergence trap, 3 April, 1992, leg. Buzby & Masteller.

Etymology.—This species is named for the island where it was collected.

Remarks: This new species has an aedeagus that resembles *Psychoda satchelli* Quate. However, the shape of the basistyles is markedly different; twice as long as wide in *P. satchelli,* but length and width equal in *P. puertoricana.*

Psychoda juliae Wagner and Masteller, New Species
(Figs. 50–53)

Description.—*Head* (Fig. 50) oval, small postocular area. Eye reniform, eye bridge with 4 rows of facets, smallest interocular distance 1 facet diameter, no interocular suture. Antenna with cylindrical scape. Twice as long as wide and twice as long as globular pedicel, flagellomeres bottle-shaped, Y-shaped ascoids. Relative length of antennal segments: 11-6-12-12-12-, distal segments missing. Relative length of maxillary palpus segments: 15-15-12-, distal segment missing.

Wing (Fig. 51) twice as long as width, venation typical of the genus. Wing length 1.56 mm. Thorax and legs without specific features.

Male genitalia uncomplicated (Fig. 52), asymmetric aedeagus. Ninth tergite rectangular, approximately twice as wide as long, 10th tergite small, distally setose. A rectangular, distally incurved sclerite between basistyles and 9th tergite, connecting left and right side of the genitalia. Cercopodia basally wide, strongly curved with one tenaculum. No sternal band. Basistyle 1.5 times longer than wide, cylindric, and ⅔ length of dististyle. Dististyles basally thin, medially narrower, increasing in width distally. Bipartite tip appears like a wrench. Aedeagus straight with blunt tip. A thin sclerite present basally, crosses above the aedeagus, its distal part thin, L-shaped.

Type material.—HOLOTYPE, ♂, **PUERTO RICO,** El Verde, Quebrada Prieta, emergence trap, 29 June, 1992 leg. Masteller.

Etymology.—This species is dedicated to Miss Julia Wagner, the senior author's daughter.

Remarks.—This new species has distally bifurcated dististyles and an almost straight aedeagus; thus cannot be confused with any other taxon.

Quatiella interdicta Quate and *Maruina hirta* Johannsen

Additional species collected in the emergence traps were *Maruina hirta,* and *Quatiella interdicta. Maruina hirta* was the most abundant taxon in the emergence traps and present almost every month of the year. A few larval samples from benthos seem to indicate the life cycle was desychronized as several larval instars (2nd–4th) were present at the same time. *Quatiella interdicta* is widely distributed from southeastern U.S.A. over a large, but unknown, area in the Caribbean islands, previously known also from Cuba, (Vaillant and Botosaneanu 1970). In the emergence traps it was quite abundant from January–July.

Acknowledgments

We are indebted to Karen Buzby for her dedication to this project and for collecting the specimens over a two-year period. Funds for partial support of this project came from the National Science Foundation (BSR-8811902) and the Institute of Tropical Forestry as part of the Long-Term, Ecological Research Program in the Luquillo Experimental Forest under the direction of Robert B. Waide. One author (ECM) received support from the Oak Ridge Associated Universities, Oak Ridge, TN, research travel program. We also acknowledge two anonymous reviewers for their diligence and helpful suggestions.

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A NEW SPECIES OF *EUTARSOPOLIPUS* (ACARI: PODAPOLIPIDAE) FROM *AMARA CALIFORNICA* DEJEAN (COLEOPTERA: CARABIDAE) FROM CALIFORNIA

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Abstract.—***Eutarsopolipus capowayensis*** Husband and Husband, n. sp. (Acari: Podapolipidae) is described from the Californian carabid beetle, *Amara californica,* and illustrated and compared with related North American *Eutarsopolipus* in the *acanthomus* group.

Key Words: Podapolipidae, mite, *Eutarsopolipus,* new species

Mites in the family Podapolipidae (Acari: Tarsonemini) are all parasites of insects. The genus *Eutarsopolipus* is restricted to Carabidae (Coleoptera) and occurs worldwide. It was erected by Berlese for *E. lagenaeformis* Berlese 1913. More than 30 species have been discovered, most of them described by Regenfuss (1968, 1974). This is the first record of *Eutarsopolipus* from the western United States.

The purpose of this paper is to describe *Eutarsopolipus capowayensis,* new species, collected from *Amara californica* Dejean (Coleoptera: Carabidae) in Poway, California, and to compare *E. capowayensis* with related members of the *acanthomus* group described by Regenfuss (1968) (e.g. *E. acanthomus, E. alarum, E. assimilis, E. crassisetus,* and *E. elongatus*), *E. pseudopus* Regenfuss 1974, *E. porteri* Husband 1993, *E. bembidii* Eidelberg and Husband 1993, *E. diunculosus* Eidelberg 1994a, and *E. diachelae* Eidelberg 1994b.

MATERIALS AND METHODS

Numerous specimens of *Eutarsopolipus* were removed from under the elytrae of 5 specimens of *Amara californicus* collected in Poway, California, and placed in vials in 70% ethanol or mounted on slides. These were compared with specimens in the reference collection of *Eutarsopolipus* spp. at Adrian College, Adrian, Michigan, U.S.A.

Measurements were taken with the aid of a Wild microscope with an ocular micrometer. All measurements are in micrometers. Setae which are no longer than the setal socket are listed as microsetae. Terminology is based on Lindquist (1986).

Eutaropolipus capowayensis Husband and Husband, NEW SPECIES

(Figs. 1–6)

Female (Figs. 1, 2).—Gnathosoma length 52–60 width 44–51. Palp length 12–15; cheliceral stylets 35–36, dorsal gnathosomal setae 13–17, ventral setae 9–10. Stigmata on stout stalks dorsolateral to base of gnathosoma, atria branch to tracheoles at the level of setae v_2.

Idiosoma: Length 405–415, width 311–390. Prodorsal plate length 94, width 206, groove between setae v_1 and v_2; setae v_1, v_2 vestigial, sc_2 50–54, setae situated distinctly anterior to posterior margin of prodorsal plate. Distance between setae v_1 57–62; v_2

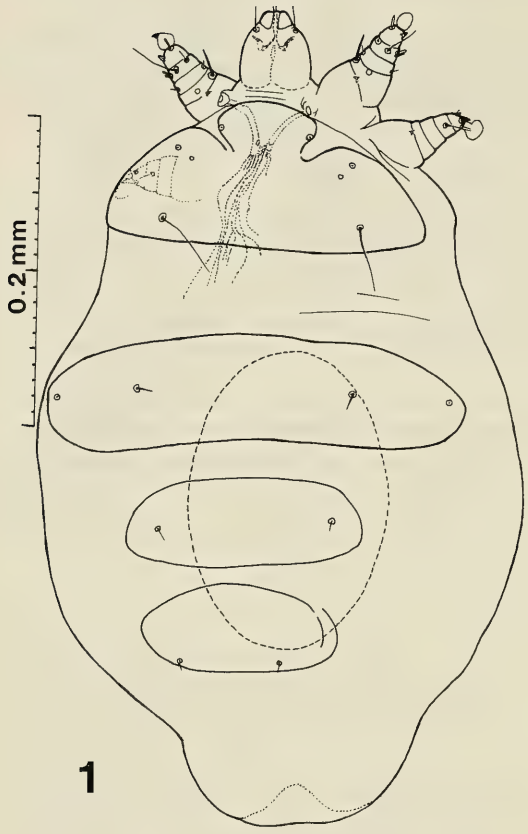

Fig. 1. *Eutarsopolipus capowayensis,* adult female, dorsal aspect.

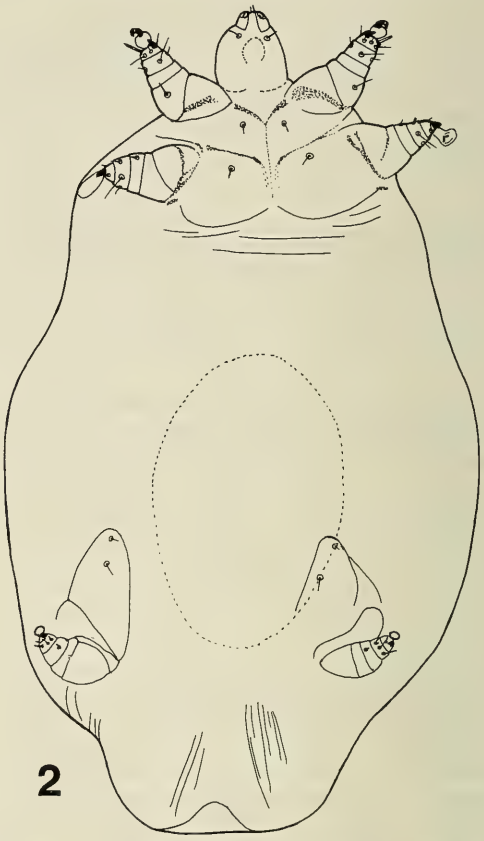

Fig. 2. *Eutarsopolipus capowayensis,* adult female, ventral aspect.

medial to a line connecting v_1 and sc_2. Plate C length 64–80, width 276–310; width vs. length ratio about 4:1. Setae c_1 13–14, c_2 vestigial. Plate D length 56, width 270, setae d 11. Plate EF length 40, width 160, setae f 6.

Venter with apodemes 1 well developed, meeting sternal apodeme medially; apodemes 2 not extending to sternal apodeme. Coxal setae 1a 8, 2a 8–10; setae 1a situated at the level of junction of apodemes 1, distance from apodeme 1 about equal to length of setae 1. Distance between setae 1a 23, distance between setae 2a 58. Setae 2a nearer sternal apodeme than trochanters 11. Coxal setae 3a 5, 3b 10.

Legs: Leg setation as in Table 1. Ambulacrum 1 with a terminal stout claw, ambulacrum 11, 111 without claws. Single tarsus 1 spine, 2 terminal spines on each of tarsi 11, 111. Tarsus 1 and tarsus 11 solenidion omega 2–3, nearly triangular. Tibial solenidion phi 9–10, finger-like. Tibial 1,11,111 setae *d* 28–33, 12–15 and 7 respectively.

Male (Figs. 3, 4).—Gnathosoma length 31–36, width 29–33. Palp length 8–10; cheliceral stylets 20–25; dorsal setae 1–4, ventral setae 3–4.

Idiosoma: Length 150–198, width 120–141. Prodorsal plate wider than long, setae v_1, v_2 vestigial, setae sc_2 20–33. Distance between setae v_2 greater than the distance between setae v_1; setae v_2 lateral to a line connecting setae v_1 and sc_2. Plates C and D fused, setae c_1, c_2, d, f and h_1 microsetae.

Genital capsule length 28, width at base 42, width at apex 16.

Table 1. Leg setation for femur, genu, tibia and tarsus for *Eutarsapolipus capowayensis* and selected species in the acanthomus group. Leg setation for an adult female *E. ochoai* Husband 1995 is included for comparison with a species with the maximum number of tarsal setae for *Eutarsopolipus*.

Species	Leg I				Leg II				Leg III			
	F	G	Ti	Ta	F	G	Ti	Ta	F	G	Ti	Ta
E. capowayensis	3	2	7	9	0	1	4	7	0	1	4	6
E. porteri	3	2	7	8	0	1	4	6	0	1	4	5
E. crassisetus	3	2	7	8	0	1	4	6	0	1	4	5
E. acanthomus[1]	3	2	6	7	0	1	4	6	0	1	4	4
E. pseudopus	3	2	7	9	0	1	4	7	0	1	4	6
E. bembidii[2]	3	2	7	8	0	1	4	6	0	1	4	5
E. diacheilae[1]	3	2	5	6	0	1	4	5	0	1	4	6
E. diunculosus[3]	3	0	4	7	0	0	4	4	0	0	4	4
E. ochoai	3	2	7	10	0	1	4	8	0	1	4	7

[1] From Eidelberg (1994b). Eidelberg listed 6 setae for tibia II in Table 2 for *E. acanthomus* but illustrated 4 setae on this segment in Figure 4. Four setae is the maximum number of setae for tibia II in Podapolipidae.

[2] From Eidelberg and Husband (1993). The setae listed here are based on the numbers of setae indicated in figure 3 of this publication, not on the numbers listed in Table 1 of this publication.

[3] From Eidelberg (1994a).

Venter: Apodemes 1,2 conspicuous but sternal apodeme weakly sclerotized; coxae 111 separated medially. Setae 1a 2, 2a 2, 3a 1, 3b 2.

Legs: Leg setation as in table 1. Ambulacrum with 1 straight claw, ambulacra 11, 111 without claws. Tarsus 1 spine-like seta *s* 4–5, tarsus 11, 111 spine-like setae *tc'* and *s* 4–6. Tarsus 1 solenidion omega 3, tarsus 11 solendion omega 2–3, solenidia nearly triangular. Tibia 1 solendion phi 5–7.

Larva (Figs. 5, 6).—Gnathosoma length 42–47, width 35–41. Palp length 10–16, cheliceral stylets 32–33, dorsal setae 16–19, ventral setae 7–9.

Idiosoma: Length 188–218, width 142–183. Prodorsal plate subtriangular, setae v_1, v_2 vestigial, sc_2 107–127. Distance between setae v_2 greater than the distance between setae v_1; setae v_2 lateral to a line connecting setae v_1 and setae sc_2. Setae c_1 10–12, c_2 vestigial, setae d 8–9. Setae c_1 and c_2 situated nearly on a straight line on the anterior ⅓ of plate C. Plate EF length 32–47, width 49–55, setae f 7–9. Plate H length 28–28, width 34–39, setae h_1 166–190, h_2 17–20, distance between setae h_1 14.

Venter: Apodemes 1,2 and sternal apodeme conspicuous but weakly sclerotized. Setae 1a 5, 2a 5, 3a 5–7 and 3b 5–7. Setae 1a, 2a and 3b stout. Setae 3a not stout.

Legs: Leg setation as in Table 1. Ambulacrum 1 with 2 slender claws. Ambulacra 11, 111 without claws. Tarsus 1 spine-like seta *s* short and stout 5, Tarsus 11 spine-like setae *tc'*, *u'* and tarsus 111 setae *u'*, 5–7. Tarsus 111 setae *tc'* 6–8. Tarsus 1 and 11 solenidia omega 2–3, tibia 1 solenidion phi 8, adjacent seta *k* 3–5. Tarsus 1 setae *tc'* 9–10, *tc''* 11–12.

Type data.—Holotype female: Poway, San Diego County, California, U.S.A., from under the elytra of *Amara californica* Dejean (Carabidae) collected by D. O. Husband, 27 December 1994. Deposited in the Acarology Collection, Museum of Zoology, University of Michigan, Ann Arbor, MI, U.S.A. (DRH122794-1).

Paratypes: 8 females, 5 males, 5 larval females, 2 eggs, 2 vials with same host and locality data as holotype. One female, 1 male, 1 larval female deposited in the National Museum of Natural History, Washington, D.C., USA.

Etymology.—The species is named for the locality, Poway, California.

Diagnosis.—Female *E. capowayensis* differ from female *E. crassisetus, E. porteri*

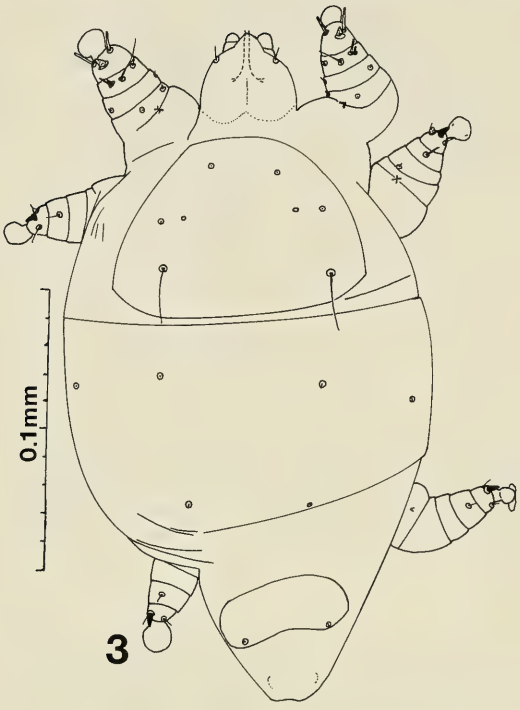

Fig. 3. *Eutarsopolipus capowayensis,* male, dorsal aspect.

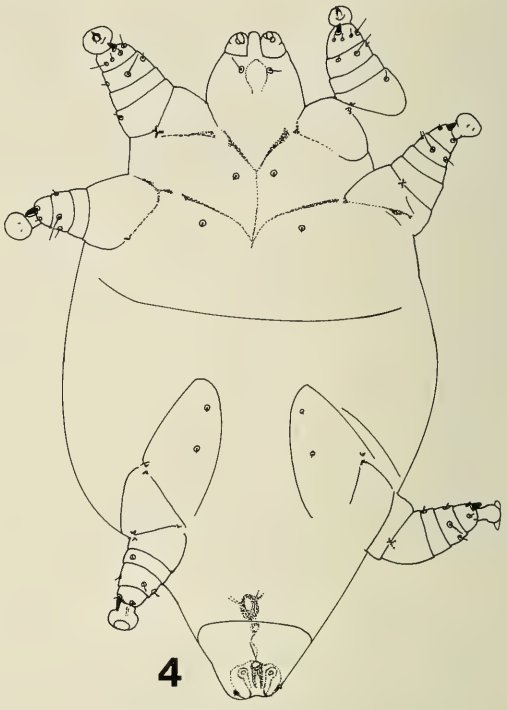

Fig. 4. *Eutarsopolipus capowayensis,* male, ventral aspect.

and *E. elongatus* in having thin coxal setae 1a and 2a. Gnathosomal setae of female *E. capowayensis* are slightly longer than those of *E. crassisetus* but are distinctly shorter than those of *E. porteri.* Grooves in the portion of the prodorsal plate which bears setae v_1 separates this portion from the remaining portion of the prodorsal plate laterally in *E. capowayensis.* Regenfuss (1968) illustrates similar grooves which are less developed in *E. crassisetus.* The remaining species in the *acanthomus* group lack these grooves.

No males are known for *E. alarum, E. assimilis, E. crassisetus* or *E. elongatus,* and Regenfuss (1968) did not illustrate a male *E. acanthomus.* Gnathosomal setae of male *E. capowayensis* are at most 4 micrometers long in contrast to 11 micrometers for dorsal gnathosomal setae in *E. porteri.* Dorsal gnathosomal setae of larval female *E. capowayensis* are at most 19 micrometers long in contrast to 21 in *E. crassisetus* and 28 in *E. porteri.* Setae c_1, d and 3a are thin in larval female *E. capowayensis* but thicker and longer in *E. porteri.* Coxal setae 3a are about equal to coxal setae 3b in *E. capowayensis* in contrast to *E. crassisetus* where coxal setae 3a are about twice the length of 3b. Coxal setae 1a and 2a are microsetae in *E. capowayensis* but are at least two times the diameter of setal sockets in *E. pseudopus, E. porteri* and *E. bembidii.* Setae v_1, v_2 are microsetae in *E. capowayensis* but these setae are longer than the diameter of the setal socket in *E. diunculosus.* Setae c_1, c_2 are nearly in a line in *E. capowayensis* but setae c_2 are posterolateral to setae c_1 in *E. diachelae.*

Regenfuss (1968) did not describe the larval female stage of *E. assimilis.* Coxal setae 1a and 2a are either on or very near apodemes 1 and 2 in larval female *E. bembidii, E. elongatus, E. crassisetus* and *E. pseudopus.* These setae are posterior to apodemes 1 and 2 in *E. capowayensis, E. acanthomus, E. alarum, E. diunculosus,* and *E.*

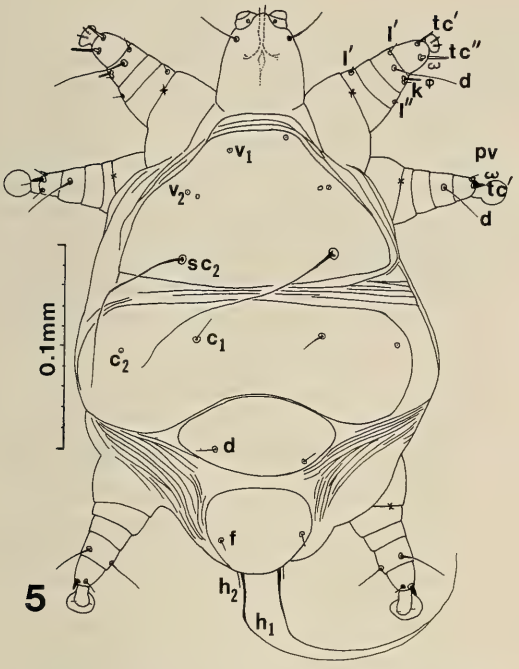

Fig. 5. *Eutarsopolipus capowayensis,* larval female, dorsal aspect.

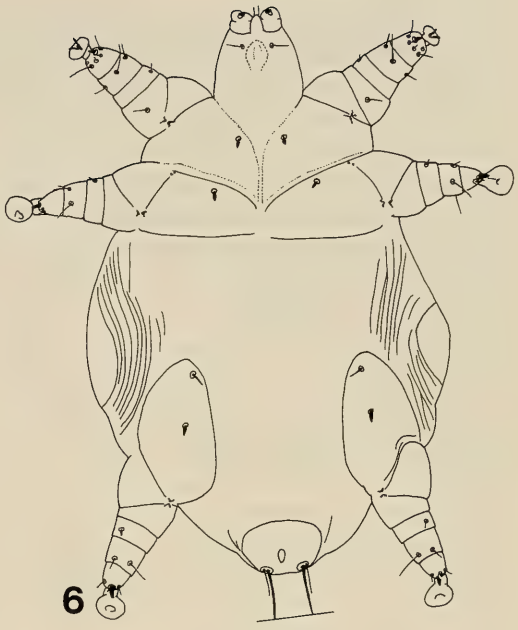

Fig. 6. *Eutarsopolipus capowayensis,* larval female, ventral aspect.

diacheilae. Of the five latter species, setae c_2 are microsetae in all species except *E. diunculosus.* Eidelberg describes setae 1a and 2a as spine-like for *E. diachelae* in contrast to styletiform in *E. acanthomus.* Setae 1a and 2a are styletiform in *E. capowayensis and E. alarum.* These setae are about two times as long as wide and far from the sternal apodeme in *E. capowayensis,* in contrast to setae 1a, 2a being at least 3 times as long as wide and long enough to touch the sternal apodeme, or nearly so.

Discussion

Regenfuss (1968) used the following synapomorphic characters to separate the *acanthomus* group of *Eutarsopolipus* from the remaining groups: females with setae v_1 and v_2 no longer than the setal socket, no apodeme 111, no setae sc_1 and ambulacra 11 and 111 without claws. He also used the following characters: females with long stout femoral L *l'* seta, males with the genital plate about as broad as long, and larval females with setae h_1 widely separated. To this may be added: males with all dorsal setae except setae sc_2 no longer than setal sockets, coxal setae 3a reduced to microsetae or vestigial; larval females with coxal setae 1a, 2a, 3b thick. The only species of the *acanthomus* complex that are reported from the Western Hemisphere are *E. crassisetus* (introduced to the United States) and *E. porteri.*

The group of *Eutaropolipus* described as the *acanthomus* group by Regenfuss (1968) included *E. acanthomus, E. alarum, E. assimilis, E. crassisetus* and *E. elongatus. E. pseudopus* Regenfuss was added later (Regenfuss 1974). Husband (1993) added *E. porteri* and reported *E. elongatus* from the United States. Eidelberg and Husband (1993) added *E. bembidii* and pointed out that *E. elongatus* in Husband (1993) is *E. crassisetus.* Eidelberg (1994a) described *E. diunculosus* and reported *E. acanthomus, E. crassisetus* and *E. elongatus* in Crimea and *E. crassisetus* from Siberia. He also described *E. diachelae* (Eidelberg 1994b). Thus, there are now 11 species in the *acanthomus* group. The three species from the

Western Hemisphere are *E. crassisetus, E. porteri* and *E. capowayensis.* This group is worldwide in distribution.

Differences between *E. capowayensis* and other species in the acanthomus group are described above. Appropriate host genera of carabid beetles for podapolipid mites exist in the Western Hemisphere and it is likely that many additional species will be discovered on appropriate carabid hosts. More study of tarsal chaetotaxy and aedeagal structures in stages and species not yet known is necessary before appropriate cladograms may be produced.

The host species for *Eutarsopolipus crassisetus* listed as *Amara aenea* in Husband (1993) has been compared to specimens determined by Fritz Hieke by George Ball and is *A. convexa* not *A. aenea.*

Acknowledgments

We are grateful to George E. Ball of the Department of Biological Sciences, University of Alberta, Alberta, Canada for the identification of the host beetles for *Eutarsopolipus capowayensis* and correction of an error in the identification of the host beetle for *E. crassisetus* collected in Michigan, U.S.A.

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TWO ADDITIONAL SPECIES OF *NOTAULACELLA* ENDERLEIN (DIPTERA: CHLOROPIDAE) FROM PANAMA

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Abstract.—Two new species, ***Notaulacella trivittata*** and ***N. argentigena,*** are described from material obtained during canopy fogging in humid forests in Panama, adding to Sabrosky's 1994 revision of the genus.

Key Words: Taxonomy, Diptera, Chloropidae, *Notaulacella,* new species, canopy fogging

A synopsis of the distinctive genus *Notaulacella* Enderlein was recently published (Sabrosky 1994), based chiefly on material collected during fogging of high forest canopy at two localities in Panama. In labeling the entire collection, it was discovered that further material of the genus had been misplaced and inadvertently overlooked. Two new species are described here, one of which had been included in the published key but left unnamed because of inadequate material. The 1994 paper contains the generic description and notes on the canopy collecting. Types of the new species are in the National Museum of Natural History, Washington, D.C.

Both new species are in the first part of the key (thorax yellow), and that part has been revised, with a subletter used to avoid upsetting the numbering in the remaining larger portion of the key.

PARTIAL REVISED KEY TO CENTRAL AMERICAN *NOTAULACELLA*

1. Thorax chiefly or entirely yellow to orange-yellow, or reddish 2
– Thorax largely black or black-brown, or almost entirely so 8
2. Scutum with three or four stripes 2a
– Scutum unicolorous, without stripes 3
2a. Scutum with four relatively narrow stripes, plus supra-alar vittula on each side . . . . . *N. vittata* Sabrosky
– Scutum with three broad stripes, obscurely separate on dorsocentral lines . . . . . *N. trivittata,* n. sp.
3. Frontal triangle yellow; fore femur distally with row of short, stout black setae antero- and posteroventrally . . . . . *N. spinosa* Sabrosky
– Frontal triangle black or dark reddish, in striking contrast to yellowish thorax; fore femur with fine hairlike setae 4
4. Frontal triangle dull or dully shining, gray microtomentose 5
– Frontal triangle smooth and polished 6
5. Frontal triangle broad and long, acute apex almost at anterior margin of frons; frons yellow outside of triangle . . . . . *N. buscki* Sabrosky
– Frontal triangle narrowly acute to middle of frons; frons broadly black on posterior ⅔ . . . . . *N. compta* (Duda)
6. Frontal triangle long, apex at anterior margin of frons; gena whitish microtomentose but relatively narrow, less than half breadth of 3rd antennal segment 7
– Frontal triangle short, apex little beyond middle of frons; gena brilliantly silvery microtomentose, ⅗ breadth of 3rd antennal segment . . . . . *N. argentigena,* n. sp.
7. Fore tarsus yellowish . . . . . *N. cabimae* Sabrosky
– Fore tarsus with at least distal 4 tarsomeres white . . . . . *N. albitarsis* Sabrosky

Couplets 8 to 17. See Sabrosky 1994.

Notaulacella trivittata Sabrosky, New Species

Diagnosis.—Scutum with 3 broad, reddish-brown, thinly microtomentose stripes.

Female. Head partly black or dark reddish brown to blackish, including back of head, frontal triangle, frons posteriorly, flanking the triangle, narrow lower edge of gena, median plate of clypeus, arista, and cephalic setae; 3rd antennal segment infuscate on distal half; rest of head yellow, the gena whitish microtomentose. Thorax chiefly dark reddish brown, the humeri and scutellum whitish yellow; thoracic setae black. Abdomen brownish yellow, tergites narrowly black margined laterally. Legs chiefly yellow, with 2 narrow fuscous bands on each tibia.

Frons slightly longer than broad; frontal triangle short and narrow, apex at or barely beyond midpoint of frons, smooth and polished mesally, with narrow band of brownish microtomentum along sides; gena narrow, less than ⅓ breadth of 3rd antennal segment and 0.07 times height of an eye. Scutum with three broad stripes, obscurely separated by slight grooves on dorsocentral lines. Legs slender, fore femur without spines.

Holotype female, Panama (Canal Zone), E shore of Gatun Lake, near Colón, humid forest, canopy fogging Tree 8, 2–14 July 1979 (E. C. Broadhead).

Etymology. The specific epithet is an adjective referring to the three-striped scutum.

This species, with dark reddish thorax, disturbs the easy division between species with yellow thorax and those with black thorax. It is definitely not black and it is conveniently associated with the lighter colored species. The three broad stripes are quite unlike the four narrow stripes of *N. vittata,* which was described as "the only vittate yellow species known in Central America."

Notaulacella argentigena Sabrosky, New Species

Notaulacella n. sp. no. 19 Sabrosky 1994: 431, 433.

Diagnosis.—Thorax yellow; frontal triangle black, short, smooth and polished; gena broad and brilliantly silvery microtomentose.

Male, female. Head predominantly yellow, only back of head, frontal triangle chiefly, arista, and setae black; gena conspicuously brilliantly silvery microtomentose. Thorax orange yellow or yellowish, setae black. Legs yellow, all tibiae with 2 narrow fuscous bands, the distal band well before apex of tibia; fore basitarsus fuscous except for narrow apex, the remaining tarsomeres whitish yellow.

Frons square, the frontal triangle moderately short, apex slightly beyond middle of frons; gena relatively broad, ⅗ breadth of 3rd antennal segment and 1/6 height of an eye. Fore femur without spines.

Holotype male, Panama (Canal Zone), E shore of Gatun Lake, near Colón, humid forest, canopy fogging Tree 3, 2–14 July 1979 (E. C. Broadhead).

Allotype, same data, but Tree 6. Paratypes: 2 males, 2 females, same data as holotype; 3 males, 1 female, same data except males from Trees 1, 4 and 6, female from Tree 7.

Etymology. The specific epithet, a noun, is derived from the Latin *argenteus,* silvery, and *gena,* cheek.

In several respects, this species resembles *N. cabimae* and *N. albitarsis,* but both of these have long frontal triangle and narrower gena, neither approaching the brilliantly silvery gena of *argentigena.* The fore tarsus of the new species is suggestive of *N. albitarsis,* but the fore tibia of that species has only the distal third infuscate, whereas *N. argentigena* has the two-banded appearance found in a number of other species of the genus, and the distal third is yellow.

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A REVISION OF THE TRIBE COLPURINI (HETEROPTERA: COREIDAE) FROM THE FIJI ISLANDS

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Abstract.—A revision of the tribe Colpurini (Coreidae) from the Fiji Islands is presented. Altogether, three genera and six species are recorded, among them are one new genus (***Monasavuhygia***) and four new species (***Brachylybas delgadoi, B. taveuni, B. vanua,*** and ***Monasavuhygia cordata***). New localities are given for *Acarihygia fijiana* Brailovsky and *Brachylybas variegata* (Le Guillou). The adult abdomen and male and female genitalia are illustrated, and a key is provided for the known species.

Key Words: Coreidae, Colpurini, Fiji, *Monasavuhygia, Brachylybas, Acarihygia*

This contribution summarizes knowledge of the tribe Colpurini (Heteroptera: Coreidae) for the Fijian Islands, bringing together information from the literature and from previously unstudied collections.

The Fijian Colpurini have never been revised. The first species recorded were by Le Guillou (1841), who described *Gonocerus variegatus,* which was later transferred by Stål (1870) into the new genus *Brachylybas.* Kirkaldy (1908) studied the Fijian Hemiptera giving new records for *B. variegata.* Brailovsky (1993) described *Acarihygia fijiana,* and Brailovsky and Martínez (1994) revised *Brachylybas* and redescribed and gave new distribution records for *B. variegata.*

In this paper I include all known species of Colpurini from Fiji Islands and describe one new genus and four new species.

The abbreviations used in this paper are: BMNH (The Natural History Museum, London); BPBM (Bernice P. Bishop Museum, Honolulu, Hawaii); QMBA (Queensland Museum, Brisbane, Australia); UNAM (Colección Entomológica del Instituto de Biología, Universidad Nacional Autónoma de México); USNM (National Museum of Natural History, Smithsonian Institution, Washington, D.C.).

All measurements are given in millimeters.

KEY TO THE FIJIAN COLPURINI

1. Ocelli absent; buccula rounded, without teeth or spine; micropterous 2
– Ocelli present; buccula with a subacute middle projection; macropterous 3
2. Neck elongate and straight; postocular tubercle absent; scutellar disc globose on each side. . . . . *Monasavuhygia cordata,* n. gen., n. sp.
– Neck very short; postocular tubercle moderately protuberant; scutellar disc flat on each side . . . . . *Acarihygia fijiana* Brailovsky
3. Male genital capsule with the posteroventral margin straight across (Fig. 11); gonocoxae I broad, and in lateral view with lower third strongly protruding into large lobes (Figs. 12–13); apical margin of corium with inner third deeply and broadly concave . . . . . *Brachylybas vanua,* n. sp.
– Male genital capsule with the middle third of the posteroventral margin exposed in two short arms or tubercles, separated along the middle line by deep longitudinal cavity (Figs. 5, 8); gonocoxae I slender, and in lateral view with the lower third rounded and barely exposed (Figs. 7, 10); apical margin of corium almost

straight, or very faintly concave near mesal end 4

4. Abdominal sternite VI of the male clearly constricted at the midline; dorsal abdominal segments VI to IX of the female strongly bent downward in straight line; abdominal sternite V to VII of the female clearly constricted at the midline . . . . . *Brachylybas variegata* (Le Guillou)

– Abdominal sternite VI of the male and V to VII of the female uniformly developed; dorsal abdominal segments VI to IX of the female almost straight 5

5. Body stout, ovate; rostrum long, reaching abdominal sternite VII; scutellar disc with the arms of the T-shaped mark strongly elevated . . . . . *Brachylybas taveuni,* n. sp.

– Body oblong, not stout; rostrum short reaching only abdominal sternite V; scutellar disc with the arms barely elevated . . . . . *Brachylybas delgadoi,* n. sp.

Acarihygia Brailovsky

Acarihygia Brailovsky, 1993: 435

The genus is best diagnosed by the following set of characters: ocelli absent, tylus apically globose, buccula rounded without teeth or spines, scutellum triangular with rounded apex, abdomen strongly convex dorsally, and female abdominal sternite VII without plica or fissura. Parameres: Figs. 22–23.

The genus was recently described by Brailovsky (1993) and includes only one species.

Type species.—*Acarihygia fijiana* Brailovsky.

Acarihygia fijiana Brailovsky (Figs. 1, 22–23)

Acarihygia fijiana Brailovsky, 1993: 436

Description.—Given by Brailovsky (1993). The only additional information is the shape of the parameres (Figs. 22–23).

Known distribution.—Fiji, Viti Levu Isl., 2–10 km., South of Nandarivatu, Yayu (near Nandarivatu) and Nandarivatu.

Other material examined.—1 ♂, 1 ♀, Fiji, Viti Levu, Nandarivatu Reserve, (850 m), 25–26 July 1987, G. Monteith and D. Cook; 1 ♂, 1 ♀, Fiji, Viti Levu, Nausori Highlands (600 m), 13 July 1987, G. B. Monteith; 1 ♂, Fiji, Viti Levu, Base of Mt. Victoria (650 m), 11 July 1987, G. B. and S. R. Monteith. (BPBM, QMBA, UNAM, USNM).

Brachylybas Stål

Brachylybas Stål, 1870. Ofv. Kong. Vetensk-Akad. 27: 653

Diagnosis.—This genus is most closely related to *Agathyrna* Stål and *Acanthotyla* Stål. The three genera have in common the presence of ocelli, a tylus projected as a short or large spine (except in *B. vanua* with apex truncate or bidentate), buccula with a median projection, antennal segment II the longest, and abdominal sternite VII of the female without plica or fissura. *Agathyrna* differs in having the femora armed ventrally; the other two genera are unarmed or have a few tubercles. In *Acanthotyla* the antenniferous tubercle has a short broad lobe externally, head quadrate and clearly wider than long, eyes substylate, and genae armed with a prominent tubercle. In *Brachylybas* Stål, the antenniferous tubercle as well as the genae are unarmed, the head pentagonal and clearly longer than wide and eyes hemispherical.

Generic redescription.—Head: Longer than wide, pentagonal, and dorsally slightly convex; antennal segment II the longest, segment III the shortest or equal than IV, and I always longer than IV; antennal segment I longer than maximum length of head; tylus projected in front of juga, upturned to form a small horn at apex or apically bifurcate; ocelli not raised; eyes hemispherical and protuberant; antenniferous tubercle unarmed, truncated; genae unarmed; mandibular plate unarmed; postocular tubercle prominent, globose; buccula elevated, short, not extending posteriorly beyond antenniferous tubercle, with subacute median projection; rostrum reaching anterior third of abdominal sternite V or

Fig. 1. *Acarihygia fijiana,* dorsal view.

apex of the last abdominal segment; neck short.

Thorax: Pronotum wider than long, trapeziform; anterior lobe shorter than posterior lobe, each margin convexly rounded; collar present; frontal angles produced forward as small or medium conical teeth; humeral angles rounded, not exposed; posterolateral and posterior borders almost straight; calli weakly or clearly convex at each side, and separated along middle line by a deep or shallow longitudinal furrow;

posterior disc with a pair of basal tubercles at each side. Discs of mesopleura and metapleura not strongly convex, and hardly visible dorsally.

Legs: Femora unarmed or with one or two rows of short tubercles; tibiae cylindrical and sulcate.

Scutellum: Triangular, wider than long; disc with a distinct T-shaped elevation, with anterior arms barely or strongly protruding; apex almost flat, subacute.

Hemelytra: Macropterous, extending to anterior margin of abdominal segment VI or almost reaching the apex of abdomen; apical corial margin straight throughout, or very faintly concave near apical third or with inner third deeply and broadly concave; membrane with a few of veins furcate.

Abdomen: Male: Connexival segments higher than margin of hemelytron at rest; posterior angles of each connexival segments complete, not extending on a short spine; dorsal segments I to VII always almost straight; abdominal sternite III to VII uniformly developed or abdominal sternite III to V and VII uniformly developed and VI constricted at midline. Female: Connexival segments similar to male; dorsal segments I to V straight, and VI to IX remarkably bent downward in straight line or dorsal segments I to IX almost straight; abdominal sternite III to VII uniformly developed, except posterior borders of sternite IV or IV and V that are weakly folded on midline or abdominal sternite III uniformly developed, sternite IV uniformly developed, except for its posterior border that is folded at midline, and sternite V to VII constricted at midline (Figs. 7, 10, 13, 16).

Male genitalia: Genital capsule: Simple, globose; posteroventral margin entire, transversely straight (Fig. 11) or with a median expansion bearing two short arms or tubercles separated along midline by deep longitudinal cavity (Figs. 5, 8, 14). Parameres. Base of body broad, internal and external margin subparallel, constricted near footlike apex, toe of extension elongate and slender (Figs. 26–27) or short (Figs. 24–25) and apically rounded.

Female genitalia: Abdominal sternite VII entire, without plica or fissura, and at middle third smooth or strongly emarginate. Genital plates. Gonocoxae I slender, enlarged dorsoventrally, straight, in caudal view with upper third opened and lower third closed, and in lateral view with external face almost straight and ventrally rounded and barely exposed (Figs. 9–10) or gonocoxae I slender, enlarged dorsoventrally, straight or obliquely straight, in caudal view almost entirely opened, and in lateral view with external face almost straight and not exposed (Figs. 15–16) or ventrally strongly exposed (Figs. 6–7) or gonocoxae I broad, enlarged dorso-ventrally, straight, in caudal view with upper third opened and lower third closed, and in lateral view external face with upper third straight and not exposed, and lower third noticeable protruding into large lobes (Figs. 12–13); paratergite VIII small, triangular, with visible spiracle; paratergite IX conspicuously enlarged, well developed and projected into middle space left by the gonocoxae I. Spermatheca: Bulb somewhat elongate, with duct relatively coiled, chamber elongate and anteriorly folded (Figs. 28–31).

This genus, as recently reviewed by Brailovsky and Martínez (1994), contained only one species, *B. variegata* (Le Guillou) from the Fiji Islands; now it is known to have four, with three of them herein described.

Type species.—*Gonocerus variegatus* Le Guillou.

Brachylybas variegata (Le Guillou)
(Figs. 14–16, 24–25, 28–29)

Gonocerus variegatus Le Guillou, 1841: 262

Brachylybas variegatus: Stål, 1870: 653

Brachylybas variegatus: Stål, 1873: 67

Brachylybas variegatus: Lethierry and Severin, 1894: 42

Brachylybas variegatus: Kirkaldy, 1908: 352

Brachylybas variegatus: Blöte, 1936: 33

Fig. 2. *Brachylybas taveuni,* dorsal view.

Brachylybas variegata: Brailovsky and Martinez, 1994: 67

Redescription.—Given by Brailovsky and Martinez (1994). The following additional information is given:

Male.—Body oval to suboval, relatively stout. Head: Longer than wide, or wider than long; tylus apically with a spiny projection; rostrum reaching anterior third of abdominal sternite V or posterior third of VI. Pronotum: Calli weakly elevated, and irregularly rounded at each side. Scutellum: Arms of the T-shaped mark barely elevated. Hemelytra: Macropterous, almost reaching apex of last abdominal segment; apical corial margin straight throughout. Abdomen: Dorsal segments straight; abdominal sternite III to V and VII uniformly developed, and VI constrained at midline. Genitalia.—Genital capsule: Posteroventral margin with medial expansion bearing two short tubercles, separated along midline by a deep longitudinal furrow (Fig. 14). Parameres: Figs. 24–25.

Female.—Abdomen: Dorsal segments I to V straight and VI to IX strongly bent downward in horizontal line; abdominal sternite III uniformly developed, IV uniformly developed except for its posterior border that is folded at midline, and sternite V to VII constricted at midline (Figs. 15–16). Spermatheca: Figs. 28–29.

Known distribution.—FIJI ISLANDS: Rewa. Vavao. Taveuni: Songgulu (10 km, SW of Waiyevo), and 4 km, NE of Somosomo. Viti Levu: Suva (Mt. Korobaba and Moronivia). Nakavuandra Range Rewasa (5 km, SE of Rakiraki). Namosi road (6 km, North of Queen's Bay). Sawani. Lami Saiyou (20 km., South of Nanduri). Naduruleulou-Waimaro (Cocoa Farm near Korovour). Savu-Savu. Tholoisuva. Nadarivatu (Mt. Lomalagi). Naitauvoli. Nausori. Ovalau: Levuka. TONGA ISLANDS: Eua (Hafu) and Ile Vavao.

Material examined.—2 ♂, Fiji, Viti Levu (3 km, E. Monasavu Dam) (1000 m), 26 July 1987, Monteith and Cook; 3 ♂, 1 ♀, Fiji, Viti Levu, Naviti Resort, 3–5 August 1994, H. and K. Brailovsky; 1 ♂, Fiji, Viti Levu, Base of Mt. Victoria (650 m), 11 July 1987, G. B. and S. Monteith. 1 ♀, Fiji, Vanua, Loma Loma, 24 March 1922, H. S. Evans. 3 ♂, 6 ♀, Fiji, Tamavua, June 1929, D. Stoner. 2 ♂, 2 ♂, Fiji, Nasurito, June 1923, Thomas. (BMNH, BPBM, QMBA, UNAM, USNM)

Notes.—This species can be easily distinguished by the constricted abdominal sternite VI of the male and V to VII of the female, as well as the strongly bent dorsal abdominal segments VI to IX of the female.

Brachylybas taveuni Brailovsky, New Species

(Figs. 2, 8–10, 26–27, 30–31)

Description.—Male: Head length 1.92; width across eyes 1.62; interocular space 0.88; interocellar space 0.51; preocular distance 1.16; postocular distance 0.26; length of antennal segments: 1, 1.96; II, 2.36; III, 1.64; IV, 1.80. Pronotum: Length of anterior lobe 0.96; length of posterior lobe 1.32; width of anterior lobe 2.20; width of posterior lobe 3.80. Scutellar length 1.80; width 2.08. Abdomen: Maximum width 4.12. Total body length 10.00.

Female: Head length 2.00; width across eyes 1.70; interocular space 0.94; interocellar space 0.43; preocular distance 1.26; postocular distance 0.28; length of antennal segments: I, 2.02; II, 2.32; III, 1.52; IV, 1.70. Pronotum: Length of anterior lobe 0.96; length of posterior lobe 1.50; width of anterior lobe 2.24; width of posterior lobe 4.00. Scutellar length 1.92; width 2.04. Abdomen: Maximum width 4.52. Total body length 10.55.

Male.—Dorsal coloration black to dark brown, with following areas pale yellow to yellowish brown; dorsal aspect of antenniferous tubercle, postocular tubercle, short longitudinal band running behind postocular tubercle, irregular spots scattered over pronotal disc, and apex of scutellum; antennal segments I and II shiny orange red, III shiny orange with basal join yellow, and IV

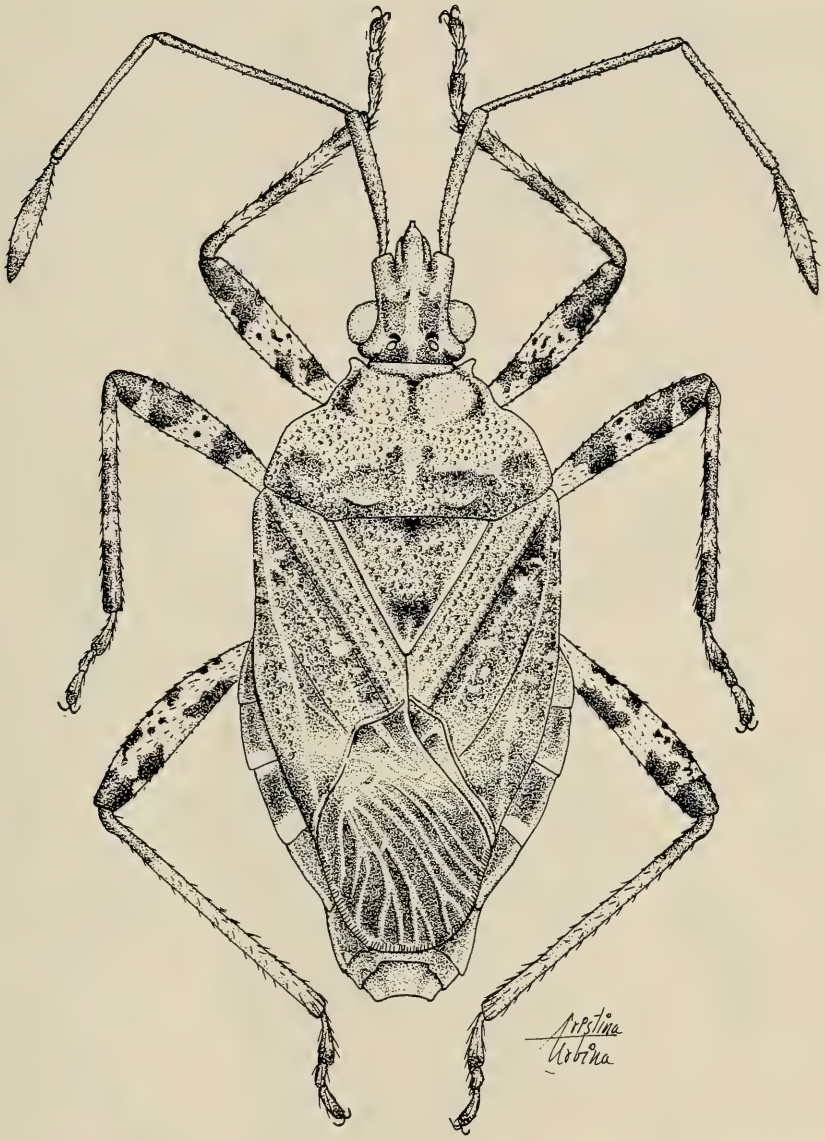


Fig. 3. *Brachylybas delgadoi,* dorsal view.

orange with middle third orange yellow to dirty yellow; tylus dark orange; hemelytral membrane dark ambarine with veins brown; connexival segments shiny orange red with posterior third yellow; dorsal abdominal segments black; following areas shiny orange red: anterolateral border of pronotum and costal margin of corium. Ventral coloration: Head black with following areas yellow: longitudinal and slender stripe running below eyes from antenniferous tubercle to neck, and rostral segments I to IV; thorax and abdomen dirty ocher yellow with following areas black: punctures, prosternum, mesosternum and metasternum, and area adjacent to metathoracic peritreme; genital capsule dark brown with orange reflections; anterior lobe of metathoracic peritreme yellow and posterior lobe orange brown; coxae shiny dark red with anterior

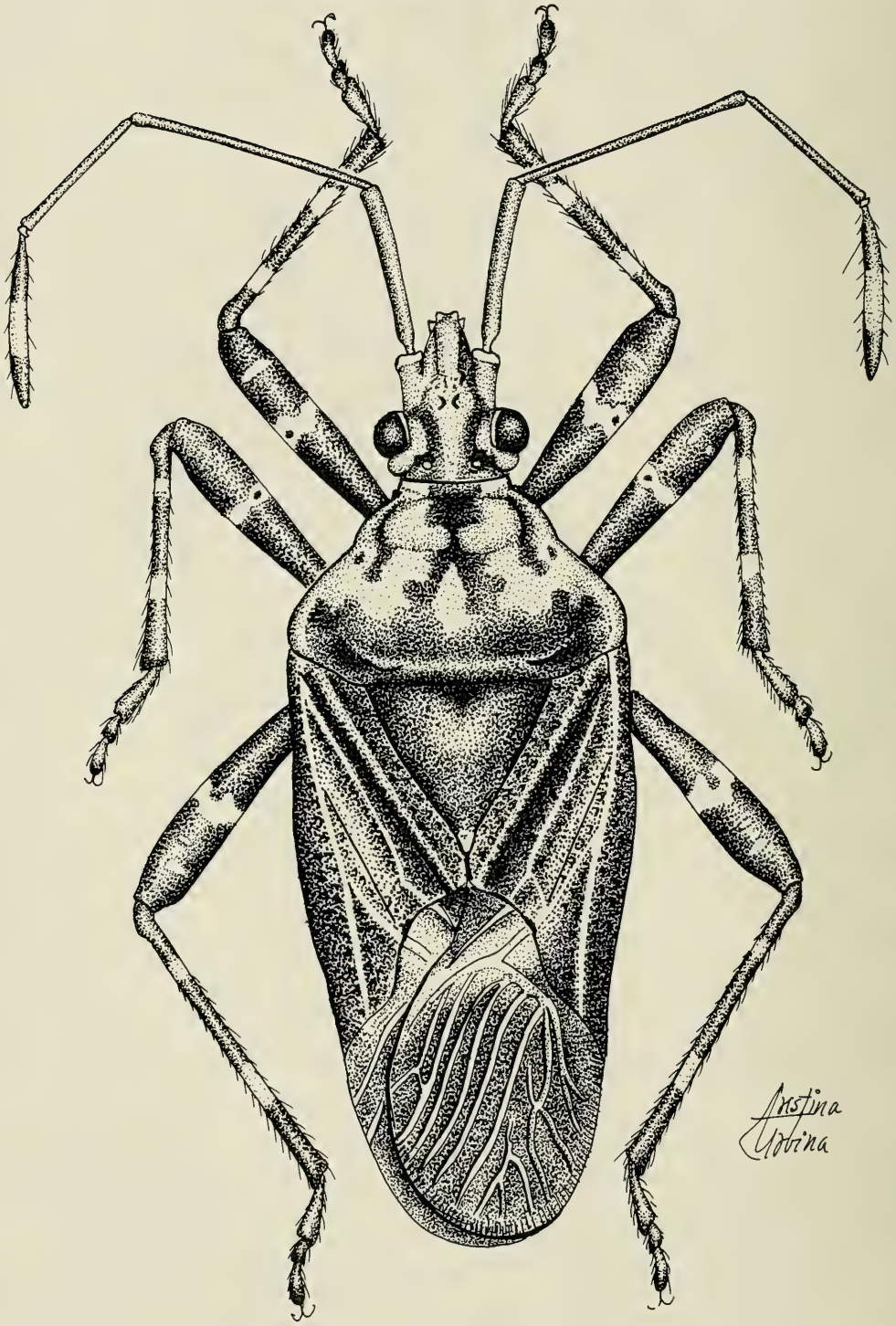


Fig. 4. *Brachylybas vanua,* dorsal view.

face mostly yellow; trochanters shiny yellow with orange red reflections; femora shiny brownish red with three or four irregular pale yellow rings; tibiae alternating two yellow rings with three red brown rings; tarsal segment I shiny orange, tarsal segment II yellow and III shiny orange with basal join yellow.

Male.—Body stout, ovate. Head: Tylus apically with a spine projection; rostrum reaching anterior or posterior third of abdominal sternite VII. Pronotum: Calli elevated, and irregularly rounded at each side. Scutellum: Arms of T-shaped mark strongly elevated. Hemelytra: Macropterous, extending to anterior margin of last abdominal segment; apical corial margin almost straight throughout. Abdomen: Dorsal segments I to VII straight; abdominal sternite III to VII uniformly developed. Genitalia.—Genital capsule: Posteroventral margin with a medial expansion, bearing two short tubercles, separated along midline by deep longitudinal furrow (Fig. 8). Parameres: Figs. 26–27.

Female.—Similar to male. Connexival segments VIII and IX shiny orange red with posterior third yellow; dorsal abdominal segments VIII and IX black; genital plates ocher with punctures red brown. Hemelytra: Extending to anterior third of abdominal tergite VI or VIII. Abdomen: Dorsal segments almost straight, not bent downward; abdominal sternite III to VII uniformly developed, except posterior border of sterna IV and V which are weakly folded; middle third of abdominal sternite VII smooth and shiny. Genitalia.—Genital plates: Gonocoxae I enlarged dorso-ventrally, slender, straight, in caudal view with upper third opened and lower third closed, and in lateral view with external face straight and ventrally rounded (Figs. 9–10). Spermatheca: Figs. 30–31.

Variation.—1, Head in dorsal view yellow with middle third including the interocellar space black to dark brown. 2, Rostral segment I yellow with apical third black or dark brown. 3, Calli and middle third of pronotal disc pale yellow to yellowish brown. 4, Femora yellow with three or four irregular rings and several discoidal spots dark red brown. 5, Abdominal sternite with the pleural margin bright orange red, except the posterior third yellow. 6, Punctures black to red brown. 7, Following areas dark orange: posterior third of pronotal disc, and anterior half of scutellar disc.

Type material.—Holotype: ♂, Fiji, Taveuni, Des Voeux Peak rd., (900–1100 m), 16 July 1987, G. Monteith and D. Cook (QMBA). Paratypes: 6 ♂♂, 9 ♀♀, Fiji, Taveuni, Des Voeux Peak rd., (900–1100 m), 16 July 1987, G. Monteith and D. Cook (QMBA, UNAM); 1 ♀, Fiji, Nagassan, W. M. Mann (BMNH).

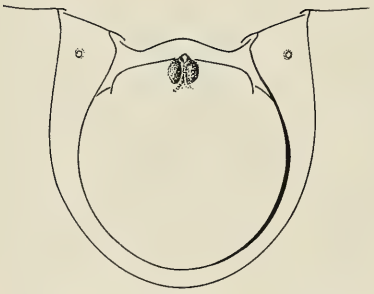
Notes.—This species is similar in color and habitus to *B. variegata* (Le Guillou). In *B. taveuni* Brailovsky, new species, the body is stout and ovate, with abdominal sternite VI of the male and V to VII of the female uniformly developed, and the rostrum reaching the abdominal sternite VII. In *B. variegata* the body is oval to subovate, relatively stout, with abdominal sternite VI of the male clearly constrained at the midline and the abdominal sternite V to VII of the female constrained, decurved and narrowed at the midline with the rostrum shorter, and not extending beyond abdominal sternite VI. In addition, the calli and arms of T-shaped ridge on the scutellar disc of *B. variegata* are weakly elevated, with the apex of parameres shorter (Figs. 24–27).

Etymology.—Named for the type locality; a noun in apposition.

Distribution.—Known only from the Fiji Islands.

Brachylybas delgadoi Brailovsky, New Species
(Figs. 3, 5–7)

Description.—Male: Head length 1.60; width across eyes 1.52; interocular space 0.80; interocellar space 0.48; preocular distance 0.98; postocular distance 0.21; length of antennal segments: I, 1.68; II, 2.10; III,



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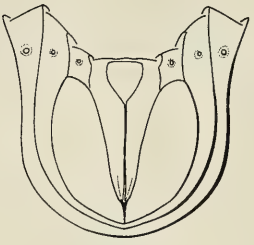

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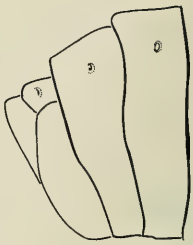

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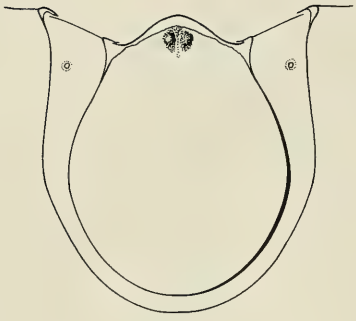

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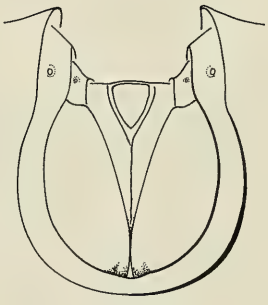

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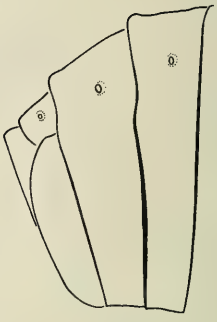

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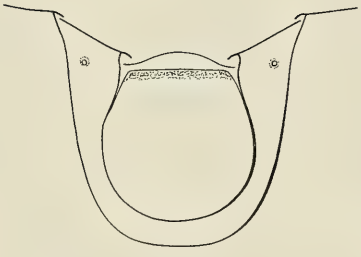

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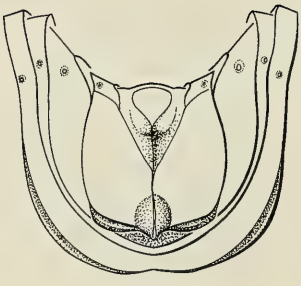

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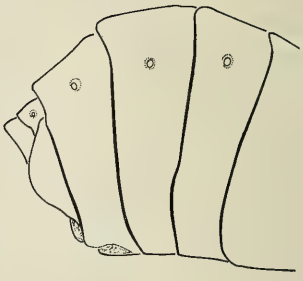

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Figs. 5–13. 5–7, *Brachylybas delgadoi.* 5, Male genital capsule, caudal view. 6, Female genital plates, caudal view. 7, Female genital plates, lateral view. 8–10, *B. taveuni.* 8, Male genital capsule, caudal view. 9, Female genital plates, caudal view. 10, Female genital plates, lateral view. 11–13, *B. vanua.* 11, Male genital capsule, caudal view. 12, Female genital plates, caudal view. 13, Female genital plates, lateral view.

1.52; IV, 1.60. Pronotum: Length of anterior lobe 0.80; length of posterior lobe 1.24; width of anterior lobe 1.80; width of posterior lobe 3.24. Scutellar length 1.50; width 1.64. Abdomen: Maximum width 3.48. Total body length 8.60.

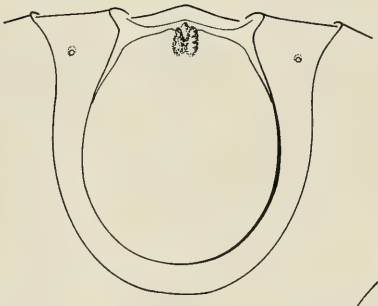
Female: Head length 1.72; width across eyes 1.64; interocular space 0.86; interocellar space 0.50; preocular distance 1.04; postocular distance 0.17; length of antennal segments: I, 1.76; II, 2.20; III, 1.58; IV, 1.60. Pronotum: Length of anterior lobe 0.80; length of posterior lobe 1.28; width of anterior lobe 1.96; width of posterior lobe 3.48. Scutellar length 1.60; width 1.76. Abdomen: Maximum width 3.92. Total body length 9.65.

Male.—Dorsal coloration pale shiny orange with following areas pale creamy yellow to yellow: basal third of tylus, a longitudinal band running from lower third of antenniferous tubercle to neck, comprising space between eyes and ocelli and dorsal aspect of postocular tubercle, two discoidal spots located on vertex, lateral margins of pronotal collar, anterolateral margins of pronotum, external edge of humeral angles, greater part of calli, irregular spotting at middle lobe of pronotal disc, scattered spots on scutellar disc, apex of scutellum, costal margin of corium, greater part of apical margin of corium, middle third of clavus, few discoidal spots scattered on exocorium, short longitudinal band of endocorium, and anterior angle and posterior border of connexival segments; antennal segments I to III bright orange (basal join of III yellow), IV shiny orange to pale brown, with middle third yellow; dorsal abdominal segments shiny orange, with punctures darker. Ventral coloration: Head pale shiny orange with following areas pale yellow: area adjacent to eyes, lateral margins of neck, and a longitudinal and slender stripe running below eyes, from antenniferous tubercle to neck; rostral segment I pale brown with subapical ring yellow, II yellow with posterior third pale brown, III and IV yellow; thorax and abdomen yellow with following areas dark red brown: prosternum, punctures, area adjacent to metathoracic peritreme, and space between middle and posterior acetabulae; anterior and posterior lobe of metathoracic peritreme yellow, genital capsule dark orange; coxae shiny dark red with orange reflections; trochanters yellow with shiny dark red reflections; femora shiny red brown with two irregular yellow rings, one subbasal, other near middle third, as well as few discoidal spots scattered on posterior third; tibiae pale orange red with one subbasal yellow ring; tarsal segment I pale orange, II and III pale yellow with apical join or posterior third pale orange.

Male.—Body oblong, not stout. Head: Tylus apically with a spine projection; rostrum reaching anterior or posterior third of abdominal sternite V. Pronotum: Calli weakly elevated, and irregularly rounded at each side. Scutellum: Arms of T-shaped ridge barely elevated. Hemelytra: Macropterous, reaching apex of last abdominal segment; apical corial margin sinuate to straight. Abdomen: Dorsal segments I to VII straight; abdominal sternite III to VII uniformly developed. Genitalia.—Genital capsule: Posteroventral margin with a medial expansion, bearing two short tubercles, separated along midline by a deep longitudinal furrow (Fig. 5).

Female.—Similar to male. Connexival segments VIII and IX pale orange red, with anterior angle and posterior border yellow; dorsal segments VIII and IX shiny orange red; genital plates pale yellow with punctures and few spots orange. Abdomen: Dorsal segments almost straight, not bent downward; abdominal sternite III to VII uniformly developed; middle third of abdominal sternite VII smooth and shiny. Genitalia.—Genital plates: Gonocoxae I enlarged dorso-ventrally, slender, in caudal view almost entirely opened, and in lateral view with lower third strongly exposed (Figs. 6–7).

Variation.—1, Body coloration pale or dark orange or black with yellow marks similar to the general description. 2, Anten-



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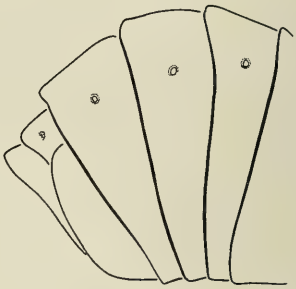

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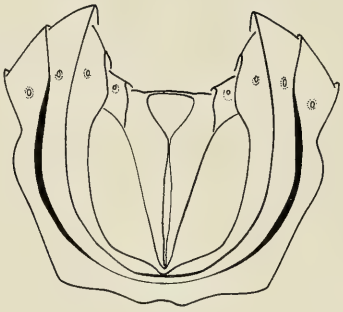

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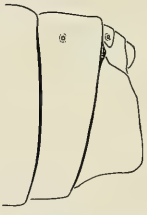

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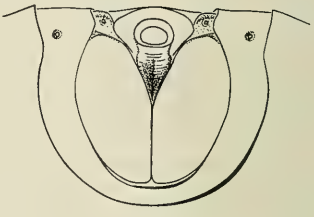

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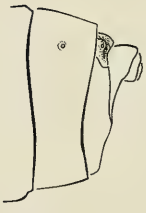

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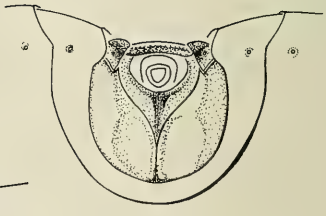

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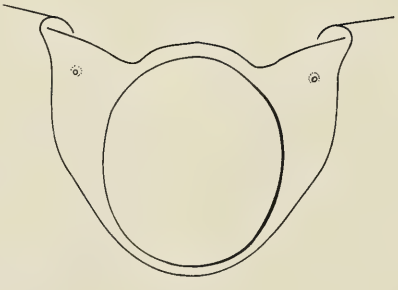

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Figs. 14–21. 14–16, *Brachylybas variegata.* 14, Male genital capsule, caudal view. 15, Female genital plates, caudal view. 16, Female genital plates, lateral view. 17–18, *Acarihygia fijiana.* 17, Female genital plates, lateral view. 18, Female genital plates, caudal view. 19–21, *Monasavuhygia cordata.* 19, Female genital plates, lateral view. 20, Female genital plates, caudal view. 21, Male genital capsule, caudal view.

nal segment III red brown with basal join yellow. 3, Rostral segment II with external face brown, and internal face yellow. 4, Trochanters yellow with external brown stripe. 5, Tibiae alternating two yellow rings with three pale orange to pale orange brown rings.

Type material.—Holotype: ♂, Fiji, Viti Levu, Suva, June 1929, D. Stoner (USNM). Paratypes: 1 ♂, 1 ♀, Fiji, Viti Levu, Suva, June 1929, D. Stoner (USNM, UNAM); 2 ♂, 2 ♀, Fiji, Walu Bay, June 1913, D. Stoner (USNM, UNAM); 1 ♂, Fiji, Kadavu Mt., Korogatule (near Matasawalevu) (300 m), 4 July 1987, G. B. Monteith (QMBA); 2 ♂; Fiji, Taveuni (L. Tagimaucia track) (300–400 m), 17 July 1987, G. Monteith and D. Cook (QMBA, UNAM); 2 ♂; Fiji, Vanua Levu, Kontiki (19 km, E of Savusavu) (20 m), 18–19 July 1987, G. Monteith and D. Cook (QMBA).

Notes.—This species is similar in color, general habitus, development of the abdomen, and shape of the male genital capsule to *B. taveuni* Brailovsky. In *B. delgadoi* Brailovsky, the body is oblong, not stout, the rostrum is shorter, reaching abdominal sternite V, and the arms of the scutellar disc are barely elevated. In *B. taveuni* the body is ovate and stout, the rostrum reaches abdominal sternite VII and the arms of the scutellar disc are strongly elevated.

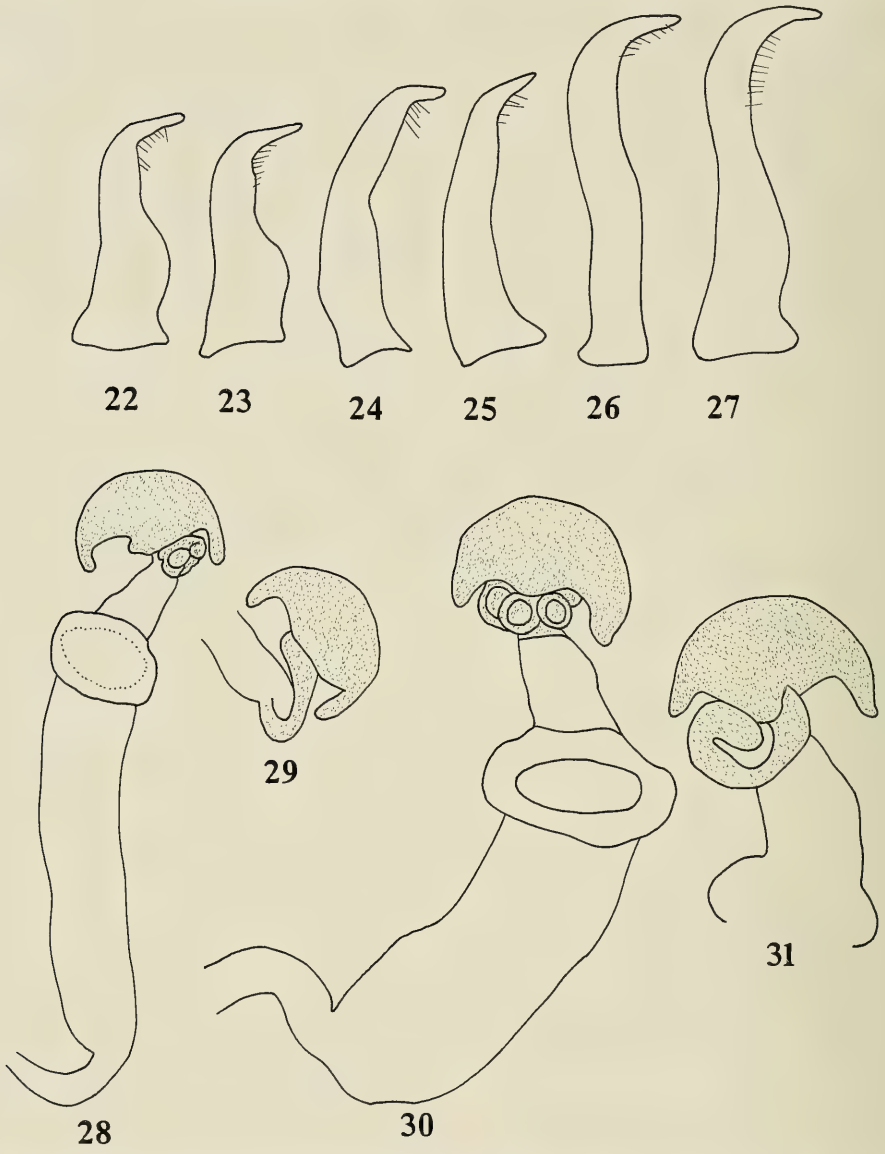
Etymology.—Named for Alfonso Delgado Salinas.

Brachylybas vanua Brailovsky, New Species
(Figs. 4, 11–13)

Description.—Male: Head length 1.52; width across eyes 1.50; interocular space 0.78; interocellar space 0.38; preocular distance 1.00; postocular distance 0.15; length of antennal segments: I, 1.64; II, 2.28; III, 1.54; IV, 1.56. Pronotum: Length of anterior lobe 0.80; length of posterior lobe 1.28; width of anterior lobe 1.88; width of posterior lobe 3.20. Scutellar length 1.64; width 1.72. Abdomen: Maximum width 3.16. Total body length 8.45.

Female: Head length 1.78; width across eyes 1.72; interocular space 0.86; interocellar space 0.48; preocular distance 1.20; postocular distance 0.25; length of antennal segments: I, 1.80; II, 2.48; III, 1.70; IV, 1.72. Pronotum: Length of anterior lobe 0.88; length of posterior lobe 1.56; width of anterior lobe 2.20; width of posterior lobe 4.04. Scutellar length 1.92; width 2.12. Abdomen: Maximum width 3.24. Total body length 9.90.

Male.—Dorsal coloration black to dark red brown, with following areas pale orange yellow to shiny orange with red reflections: tylus, a longitudinal band running from the antenniferous tubercle to neck, comprising space between eye and ocelli and dorsal aspect of postocular tubercle, two discoidal spots located on vertex, lateral margins of pronotal collar, anterolateral margins of pronotum, external edge of humeral angles, greater part of calli, an irregular spotting at middle lobe of pronotal disc, apex of scutellum, costal margins of corium, and anterior angles and posterior border of connexival segments; antennal segments I and II bright orange, III dark red brown with basal join yellow, and IV dark or pale red brown with middle third pale yellow; hemelytral membrane dark ambarine with veins brown. Ventral coloration: Head black, with following areas yellow to shiny orange: area adjacent to eyes, lateral margins of neck, and a longitudinal and slender stripe running below eyes, from antenniferous tubercle to neck; rostral segment I dark red brown, with subapical yellow ring, II with external face dark red brown and internally yellow, III and IV shiny yellow; thorax, abdomen, and genital capsule orange yellow with following areas black: prosternum, mesosternum, metasternum, area adjacent to metathoracic peritreme, and some punctures; anterior lobe of metathoracic peritreme dirty orange, and posterior lobe red brown; coxae shiny dark red with orange reflections; trochanters yellow with shiny dark reflec-



Figs. 22–31. 22–27, Parameres. 22, 23, *Acarihygia fijiana.* 24, 25, *Brachylybas variegata.* 26, 27, *B. taveuni.* 28–31, Spermatheca. 28, 29, *B. variegata.* 30, 31, *B. taveuni.*

tions; femora dark red brown with two irregular yellow rings, one subbasal, other near middle third; tibiae pale red brown to pale red orange brown with two incomplete pale yellow rings; tarsal segment I shiny orange, II and III pale yellow with apical join or posterior third.

Male.—Body oblong, not stout. Head: Tylus apically truncate or bidentate; rostrum reaching anterior third of abdominal sternite VI. Pronotum: Calli weakly elevated, and irregularly rounded at each side. Scutellum: Arms of T-shaped ridge barely elevated. Hemelytra: Macropterous, reaching apex of last abdominal segment; apical corial margin with inner third deeply and broadly concave, Abdomen: Dorsal segments I to VII straight; abdominal sternite

III to VII uniformly developed. Genitalia. Genital capsule: Posteroventral margin entire, transversely straight (Fig. 11).

Female.—Similar to male. Connexival segments VIII and IX, black to dark red brown with posterior third yellow; dorsal segments VIII and IX dark red brown; genital plates orange yellow with punctures red brown. Abdomen: Dorsal segments almost straight; abdominal sternite III to VII uniformly developed; middle third of abdominal sternite VII strongly raised. Genitalia.-Genital plates: Gonocoxae I broad, enlarged dorso-ventrally, in caudal view with upper third opened and lower third closed, and in lateral view external face with upper third straight and not exposed and lower third noticeable protruding into large lobes (Figs. 12–13).

Type material.—Holotype: ♂, Fiji, Vanua Levu, Savusavu Labasa Div., (500 m), 20 July 1987, Monteith and Cook (QMBA). Paratypes: 1 ♂, 1 ♀, Fiji, Vanua Levu, Savusavu Labasa Div., (500 m), 20 July 1987, Monteith and Cook (QMBA, UNAM).

Notes.—*Brachylybas vanua* Brailovsky, is easily distinguished by the shape of the male genital capsule, in which the posteroventral margin is entire and transversely straight (Fig. 11) and the female genital plates gonocoxae I broad, and in lateral view with lower third strongly protruding into large lobes (Figs. 12–13). In addition, the apical margin of corium has the inner third deeply and broadly concave and the middle third of abdominal sternite VII of the female conspicuously emarginate and raised. For the other known Fijian species of *Brachylybas,* the apical margin of corium is almost straight, or very faintly concave near mesal end, and the middle third of abdominal sternite VII of the female always smooth.

Etymology.—Named for the type locality; a noun in apposition.

Distribution.—Known only from the type locality in the Fiji Islands.

Monasavuhygia Brailovsky, New Genus

Diagnosis.—*Acarihygia* Brailovsky, like *Monasavuhygia* Brailovsky, has the ocelli absent, tylus apically globose and truncate, buccula rounded without teeth or spines, abdominal segments IV to VI strongly convex, higher than connexivum, micropterous, legs unarmed, tibiae with indistinct sulcus, pronotum clearly bilobed, and the abdominal sternite VII of the female without plica or fissura. In *Acarihygia,* the neck of the head is very short, the postocular tubercle moderately protuberant, disc of the scutellum flat, abdomen conspicuously spherical, posterior third of each connexival segment flat, and gonocoxae I squarish, large, and in lateral view, with a convex and protruding external margin (Figs. 17–18). *Monasavuhygia* is recognized by the neck elongate and straight, postocular tubercle absent, disc of the scutellum with prominent and obtuse tubercle at each side, abdomen not spherical, posterior third of each connexival segments globose, and gonocoxae I in lateral view remarkable flat (Figs. 19–20).

Generic description.—Head: Longer than wide, pentagonal, and dorsally slightly convex; tylus unarmed, apically globose, extending anteriorly to and laterally higher than juga; jugum unarmed, thickened, and conspicuously shorter than tylus; antenniferous tubercle unarmed, globose, diverging anteriorly, with apex truncate; side of head in front of eye unarmed, concave; antennal segment I robust, thickest, slightly curved outward, shorter than head; segments II and III cylindrical and slender; segment IV fusiform; segment II longest, segment III the shortest, and I subequal to IV; ocelli absent; posterior pit between eyes deep; eyes globose, and protuberant; postocular tubercle absent; buccula elevated, short, not projecting beyond antenniferous tubercle, without teeth, and with external edge sinuate; rostrum long, reaching the apex of last abdominal sternite; rostral segment IV longest, segment I the shortest, and II and III sub-

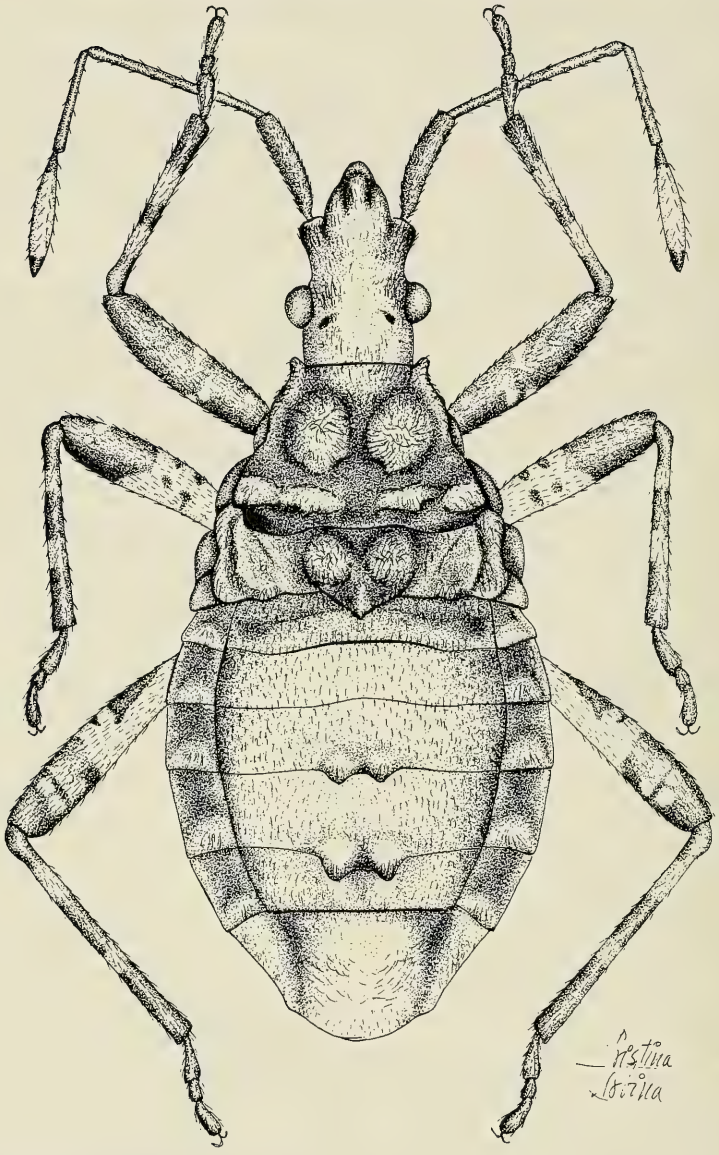


Fig. 32. *Monasavuhygia cordata,* dorsal view.

equal; rostral segment I reaching posterior gular region; neck elongate, straight.

Thorax: Pronotum wider than long, trapeziform and clearly bilobed; anterior lobe longer than posterior lobe, lateral margin of each convexly rounded; collar wide; frontal angles produced forward as small conical teeth; humeral angles weakly globose, not exposed; posterolateral and posterior border almost straight; disc with large, elevated, irregularly rounded callus at each side, behind anterior margin, and separated along middle line by a longitudinal depression; middle with a pair of basally joined tubercles at each side; posterior lobe with a deep circular depression located medially. Anterior lobe of metathoracic peritreme reniform, posterior lobe sharp, small. Discs of mesopleura and metapleura strongly convex, visible dorsally; posterior border of

metathorax with upper third visible dorsally.

Legs: Unarmed; tibiae cylindrical, longitudinal sulcus indistinct.

Scutellum: Cordiform, wider than long, with a prominent and obtuse tubercle at each side; apex rounded.

Hemelytra: Micropterous; wings reduced to small pads, widely separated; abdomen exposed mesially; clavus and corium fused; membrane absent; disc with two prominent tubercles, one close to middle line, the second at the apical margin.

Abdomen: Abdominal segments IV to VI strongly convex, higher than connexivum; dorsal segment VII flat, with connexival segment VII higher; connexival margin entire, posterior third globose, and posterior angle of each segment not extended into short spine; abdominal sternite with medial sternal furrow projecting to anterior third of sternite V.

Integument: Body rather dull; acetabulae, mesothorax, metathorax, and abdominal sterna polished; thorax, abdominal sternite, and exposed parts of genital segments of both sexes strongly punctate. Head, pronotum, scutellum, hemelytra, and abdominal segments with short, decumbent golden bristlelike setae; abdominal sterna with few long erect setae; antennal segments and legs covered by long and short erect setae.

Male genitalia: Genital capsule simple, globose; posteroventral edge entire, rounded (Fig. 21).

Female genitalia: Abdominal sternite VII entire, without plica or fissura. Genital plates. Gonocoxae I squarish, large, external margin emarginate, and in lateral view flat; paratergite VIII short, with visible spiracle; paratergite IX squarish, larger than paratergite VIII (Figs. 19–20).

Etymology.—Named for its occurrence in Monasavu (Fiji Islands). Gender feminine.

Type species.—*Monasavuhygia cordata* Brailovsky, new species.

Monasavuhygia cordata Brailovsky, New Species

(Figs. 19–21, 32)

Description.—Male: Head length 1.84; interocular space 0.80; width across eyes 1.32; preocular distance 1.16; postocular distance 0.36; length of antennal segments: I, 1.12; II, 1.80; III, 1.04; IV, 1.12. Pronotum: Length of anterior lobe 0.92; length of posterior lobe 0.44; width of anterior lobe 1.16; width of posterior lobe 2.36. Scutellar length 0.72; width 1.00. Total body length 8.16.

Female.—Head length 2.00; interocular space 0.84; width across eyes 1.40; preocular distance 1.20; postocular distance 0.46; length of antennal segments: I, 1.20; II, 1.96; III, 1.04; IV, 1.20. Pronotum: Length of anterior lobe 0.96; length of posterior lobe 0.48; width of anterior lobe 1.20; width of posterior lobe 2.56. Scutellar length 0.80; width 1.12. Total body length 8.90.

Male.—Dorsal coloration: Body dark orange brown; antennal segments I to III orange red, and IV yellow with basal join brown. Ventral coloration: Head dark brown, with rostral segments I to IV yellow to pale orange yellow; thorax dark brown with following areas shiny dark orange: acetabulae, mesopleura and metapleura; coxae shiny red brown, with shiny dark orange reflections; trochanters shiny dark orange; fore and middle femora with anterior third of anterior half yellow and scattered with red brown discoidal spots and the rest red brown; hind femora red brown with two incomplete pale yellow rings, one subbasal the other near the middle line (internal side mostly yellow); tibiae alternating two yellow rings with three red brown rings; tarsal segments pale orange yellow; anterior and posterior lobe of metathoracic peritreme dirty orange yellow; abdominal sterna shiny red brown with pleural margins shiny orange yellow; genital capsule dull orange red, scattered with pale orange yellow discoidal spots.

Female.—Dorsal coloration: Head pale orange brown with dirty yellow reflections; antennal segments I to III shiny orange red, and IV yellow with basal join brown; pronotum pale orange to pale yellow with following areas dark red brown: anterior margin, and a wide longitudinal band running between calli and reaching posterior margin; scutellum dark red brown with apex and tubercles shiny orange red; hemelytra dark red brown with tubercles shiny orange yellow; abdomen dark red brown, scattered with few dirty orange yellow discoidal spots; posterior third of each connexival segments dirty orange. Ventral coloration: Similar to male. Genital plates shiny to pale orange yellow, with punctures dark red brown.

Type material.—Holotype: ♂, Fiji, Viti Levu Isl., 3 km., East of Monasavu Dam (1000 m), 26 July 1987, Monteith and Cook (QMBA). Paratypes: 2 ♀♀, Fiji, Viti Levu Isl., 3 km., East of Monasavu Dam (1000 m), 26 July 1987, Monteith and Cook (QMBA, UNAM); 1 ♀, Fiji, Viti Levu Isl., Mt. Victoria (1100–1341 m), 25 July 1987, G. Monteith and Cook (QMBA).

Etymology.—Named for the heart-shaped scutellum.

Distribution.—Known only from the type locality in the Fiji Islands.

Acknowledgments

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REVIEW OF THE GASTERUPTIIDAE (HYMENOPTERA) OF EASTERN NORTH AMERICA

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Abstract.—Five species of Gasteruptiidae are known in eastern North America. Known hosts are bees and wasps nesting in wood or twigs. A key is given for their identification, and distributions and known hosts are reviewed. Seasonal activity is presented based on collections from the mid-Atlantic United States. The peak flights are from May to July, but adults are present from the end of April into October.

Key Words: Gasteruptiidae, eastern North America, key, hosts, seasonal occurrence

Species of Gasteruptiidae (also in some literature as Gasteruptionidae) are parasitoids in the nests of Apoidea, Sphecoidea, and possibly Vespoidea, which nest in wood or in twigs. Few hosts are known, and little is known of the biology of Gasteruptiidae in North America. Adults are commonly found on flowers, especially Apiaceae (= Umbelliferae), or in flight while exploring around stumps, logs, or posts. Townes (1950) treated 15 North American species, five of which he further divided into two or more subspecies, and recognized two genera, *Gasteruption* Latreille and *Rhydinofoenus* Bradley. Crosskey (1962) recognized six genera in his study of the world fauna. He separated five small genera that occur in the Neotropical and Australian regions, but he could not satisfactorily divide the large, worldwide genus *Gasteruption* into smaller units. Therefore, all North American species are currently placed in *Gasteruption.*

Five species occur in eastern North America. I collected four species including large series of three of them while Malaise trapping in the mid-Atlantic states over the past 13 years. Based on collections of 946 specimens, the following review is presented, including updated information on hosts, distributions, and seasonal activity.

Townes (1950) based subspecies of *G. assectator* (L.), *G. kirbii* (Westwood), *G. tarsatorium* (Say), and *G. floridanum* (Bradley) on color differences. Carlson (1979) did not recognize subspecies for *G. assectator.* I have not recognized subspecies; however, for reference, I mention previous usage in the species introductions. Users may refer to Townes (1950) for more details if they prefer to use subspecific names.

Materials and Methods

Collections were by Townes-style Malaise traps (Townes 1972) using 95% ethyl alcohol as a killing agent in most traps and potassium cyanide only in those at Green Ridge State Park, Maryland. Traps were in continuous operation from March or April through October or November each year, depending on the site, and serviced every ten days to two or three weeks, depending on the weather and time of year. Collection

sites are as follows, with years of trapping and number of traps used at each site: MARYLAND: Beltsville Agricultural Research Center, 2–6 mi W Beltsville, Prince George's Co. (1991–1993, 3–4 traps); Finzel Swamp, 1 km S Finzel, Garrett Co. (1992–1993, 2 traps); Green Ridge State Park, 6 mi E Flintstone, Allegany Co. (1991–1993, 6 traps). VIRGINIA: Fairfax Co., nr Annandale (1981–1994, 1 backyard trap); Essex Co., 1 mi SE Dunnsville (1991–1994, 12–16 traps); Clarke Co., University of Virginia Blandy Experimental Farm and State Arboretum of Virginia, 2 mi S Boyce (1990–1994, 5–13 traps); Louisa Co., 4 mi S Cuckoo (1985–1989, 1–12 traps). WEST VIRGINIA: Tucker Co., Fernow Experimental Forest, south of Parsons (1991–1993, 20–24 traps); Hardy Co., 3 mi NE Mathias (1994, 2 traps). Although the number of traps at a given site sometimes varied from year to year, the number of traps used for each season was the same for the entire collecting period.

In the "specimens examined" sections, references to these sites are by state and county, and years of collection are given only when one or a few specimens were collected. Specimens are deposited in the National Museum of Natural History, Washington, D.C.

For references to original descriptions and synonymy, see Townes (1950) and Carlson (1979). Records in the distribution sections are from Townes (1950) and specimens in the National Museum of Natural History. Records in the specimens examined sections are from my collections.

Key to Species

1. Ovipositor sheath ⅓ to ½× forewing length (Fig. 1); female subgenital plate with broad V-shaped notch; pronotal tooth blunt or obsolete; texture of head dull, granulose (Fig. 4); hindtarsus rarely marked with white (tegula black) 2
– Ovipositor sheath 2 to 2 ½× forewing length (similar to Fig. 9); female subgenital plate with narrow, deep, slit-shaped notch; pronotal tooth usually distinct and acute (as in Fig. 10); head shining (Fig. 12); hindtarsus often marked with white 3
2. Sculpturation on side of thorax, especially lower mesopleuron, metapleuron, and propodeum, relatively coarse; mesonotum with somewhat more evident transverse striation (Figs. 2, 3) . . . . . *.assectator* (Linnaeus)
– Sculpturation on side of thorax and propodeum finer and more granular in appearance; mesonotum with finer punctures and less conspicuous striation (Figs. 5, 6) . . . . . *kirbii* (Westwood)
3. Tegula black; mesonotal lateral lobes with weak, medium to small punctures (Fig. 8) (fore- and midtibiae whitish at base, rest brown or reddish). . . . . *barnstoni* (Westwood)
– Tegula light orange to reddish brown; mesonotal lateral lobes often with some large, strong punctures (Figs. 11, 14) 4
4. Fore- and midtibiae reddish brown, somewhat paler basally; propleuron with some rather coarse transverse wrinkles (Fig. 10); side of thorax with shiny interspaces between punctures, not densely hairy (Fig. 10); pronotum black . . . . . *.floridanum* (Bradley)
– Fore- and midtibiae with an external white stripe from base to apex, or white basally and apically with white areas elongate externally; propleuron without coarse transverse wrinkles (Fig. 13); texture of side of thorax dull between punctures, hairs dense (Fig. 13); posterior corner of pronotum usually with dull-orange spot . . . . . *tarsatorium* (Say)

Gasteruption assectator (Linnaeus) (Figs. 1–4, 15)

This is a holarctic species. Townes (1950) recognized several subspecies in North America. The common one in the East was under the name *G. assectator arca* (Couper). Carlson (1979) did not recognize subspecies.

Diagnosis.—Ovipositor sheath ⅓ to ½ of forewing length; female subgenital plate with broad V-shaped notch; pronotal tooth blunt to obsolete; head texture dull and granulose; tegula black; thorax with relatively coarse sculpturation (compare Figs. 2 and 3 with Figs. 5 and 6 for separation from *kirbii*).

Distribution.—Nova Scotia to Alaska south to North Carolina, Kansas, Arizona, and California; Eurasia. Eastern North America: Connecticut, Illinois, Indiana,

Figs. 1–6. 1–4, *Gasteruption assectator.,* female 1, Lateral view. 2, Lateral view of thorax. 3, Dorsolateral view of thorax. 4, Front view of head. Length, ca. 10 mm, without ovipositor. 5–6, *Gasteruption kirbii,* female. 5, Lateral view of thorax. 6, Dorsolateral view of thorax. Length, ca. 10 mm, without ovipositor.

Iowa, Kansas, Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Newfoundland, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Nova Scotia, Ohio, Ontario, Pennsylvania, Quebec, Rhode Island, South Dakota, Vermont, Virginia, West Virginia, Wisconsin.

Specimens examined.—Total: 260. MARYLAND: Garrett Co. 21–30.V to 28.IX–15.X (77); Prince George's Co. 3–15.V to 30.V–12.VI (6). VIRGINIA:

Figs. 7–8. *Gasteruption barnstoni,* female. 7, Lateral view of thorax. 8, Dorsolateral view of thorax. Length, ca. 14 mm, without ovipositor.

Clarke Co. 28.IV–10.V to 21.VII–5.VIII (105); Essex Co. 22.IV–3.V to 1–10.VI (24); Fairfax Co. 28.IV–5.V to 30.VII–5.VIII (30); Louisa Co. 1–12.V to 8–19.VI (9). WEST VIRGINIA: Hardy Co., 15.V–10.VI.1994 (3); Tucker Co. 21–30.V to 20–29.VII (6).

Hosts.—Reared from *Carya glabra* (Mill.) Sweet in New York, from climbing bittersweet in Pennsylvania, from pemphredonine (Sphecidae) in a rose stem in Ohio, and from cocoon under bark in Ontario (Townes 1950). Carlson (1979) gave *Hylaeus ellipticus* (Kirby) (Colletidae) and *Megachile rotundata* (F.) (= *M. centuncularis* (L.)) (Megachilidae) as hosts. Treherne (1916), cited the hosts of *Foenus incertus* Cresson (a synonym of *G. assectator*), as "bees." Further associations from labels on specimens from various localities, mostly representing adult collection data, include: from wild carrot; from flowers of *Aruncus aruncus* L.; on dead oak tree; reared from sumac stem; on *Hydrangea arborescens* L.; *Pinus murryana* Balf. (= *Pinus contorta* Dougl.); swept goldenrod; and ex gall of "*Rhodites tuberculator*" (= *Diplolepis tuberculatrix* (Cockerell) (Cynipidae)). Höppner (1904) reported on the biology in Europe, with the host as *Prosopis* spp. (now treated as a subgenus of *Hylaeus*).

Discussion.—*Gasteruption assectator* is very close to *G. kirbii,* and the two are very difficult to separate. So far as I can tell, all specimens I have collected as cited in the specimens examined section are *G. assectator.*

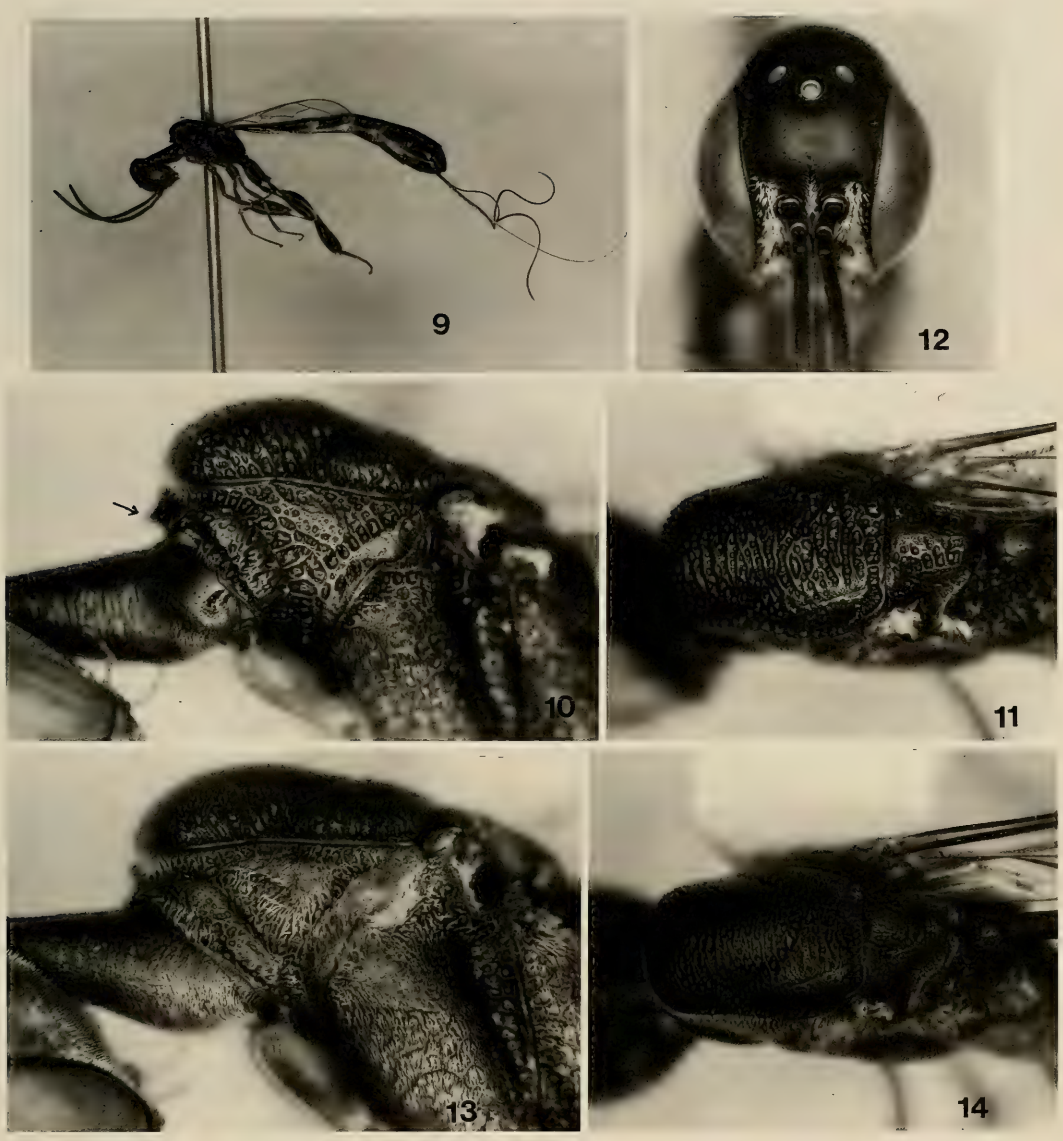
According to Townes (1950) collection dates for most specimens are from May 30 to September 10, with April 26 the earliest record and September 15 the latest record. I have found the first specimens of the season in late April, and the species is present through the first third of October (Fig. 15). There is a peak from mid-May through mid-June, but populations appear to be rather steady from May through July, with lower populations in August and September.

Gasteruption barnstoni (Westwood)
(Figs. 7, 8)

Townes recognized the typical subspecies from eastern North America to western Canada and one other subspecies, *G. b. perplexus* (Cresson) from the Rocky Mountains westward. The two subspecies were separated by color and slight sculpture differences on top of the head. Carlson (1979) indicated that these may not be meaningful subspecies.

Diagnosis.—Ovipositor sheath more than 2× forewing length; tegula black; mesonotal lateral lobe with weak, medium to small punctures; fore- and midtibiae whitish at base, remainder brown to reddish.

Distribution.—Eastern Canada and United States to Alaska, south to Virginia, Ohio,



Figs. 9–14. 9–11, *Gasteruption floridanum,* female. 9, Lateral view. 10, Lateral view of thorax; arrow points to pronotal tooth on right side of thorax. 11, Dorsolateral view of thorax. Length, ca. 14 mm, without ovipositor. 12–14, *Gasteruption tarsatorium,* female. 12, Front view of head. 13, Lateral view of thorax. 14, Dorsolateral view of thorax. Length, ca. 14 mm, without ovipositor.

Illinois, New Mexico, Arizona, California. Eastern North America: Alberta, Connecticut, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Brunswick, New Hampshire, New York, Nova Scotia, Ohio, Ontario, Pennsylvania, Prince Edward Island, Quebec, Saskatchewan, Vermont, Virginia, West Virginia.

Specimens examined.—Total: 13. MARYLAND: Garrett Co. 20–29.VI to 8–17.IX (10). VIRGINIA: Essex Co., 22.IV–17.V.1994 (3).

Hosts.—Unknown.

Discussion.—According to Townes (1950) most collection records are from June 20 to August 10, with June 5 the ear-

liest record and September 22 the latest record. This is a more northern species, and I have found only a few specimens at Finzel Swamp, Garrett Co., Maryland, and in Essex Co., Virginia. The Maryland, West Virginia (Bolivar, Jefferson Co.), and Virginia records are the southernmost in eastern North America for this species.

Gasteruption floridanum (Bradley)
(Figs. 9–11, 16)

Townes (1950) recognized the typical subspecies from North Carolina, Georgia, Florida, and Cuba and *G. floridanum bradleyi* Townes over the rest of its range. They were separated by color, the more southern subspecies with the thorax largely reddish and the wings slightly darker.

Diagnosis.—Ovipositor sheath about 2× forewing length; tegula light reddish; mesonotal lateral lobes with some large, strong punctures; fore- and midtibiae somewhat whitish basally, remainder reddish; propleuron with rather coarse transverse wrinkles; thorax with shiny interspaces between ridges and punctures, hairs usually present but not so dense as to obscure surface; pronotum black.

Distribution.—Eastern North America: Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Kansas, Maine, Maryland, Massachusetts, Missouri, Mississippi, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Ontario, Pennsylvania, Rhode Island, Texas, Virginia, Wisconsin.

Specimens examined.—Total: 248. MARYLAND: Allegany Co. 1–10.VII (1); Garrett Co. 30.VI–9.VII to 30.VII–9.VIII (3). VIRGINIA: Clarke Co. 10–21.V to 29.IX–22.X (149); Essex Co. 12–29.IV to 17.IX–10.X (71); Fairfax Co. 5–11.VI and 8–19.VII (2); Louisa Co. 24.IV–4.V to 12.IX–6.X (22).

Hosts.—Walkley (1967) gave two host records, *Hylaeus cressoni* (Cockerell) (Colletidae) and *Trypoxylon frigidum* Smith (Sphecidae), but Carlson (1979) did not give host records as he found no specimens bearing such host data and stated that he had reason to doubt the identity of the parasites. I was also unable to find such records. However, Hurd (1979) listed *G. floridanum* as a parasite of *Hylaeus mesillae cressoni,* probably based on Walkley's record. According to specimen labels, adults have been collected from flowers of *Cicuta maculata* L.; flowers of *Ceanothus americanus* L.; wildflowers; *Daucus carota* L.; from *Polygonum*; and from *Polygonum hydropiperoides* Michx.

Discussion.—Townes (1950) indicated that most specimens were collected in June, July, and August, with the earliest record of March 19 and latest record of October 18. I have collected this species from the end of April through the first third of October (Fig. 16). The peak flight period is mid-May through the first third of June and populations appear to be high through mid-July. Populations are lowest from the end of July through the rest of the season.

Gasteruption kirbii (Westwood)
(Figs. 5, 6)

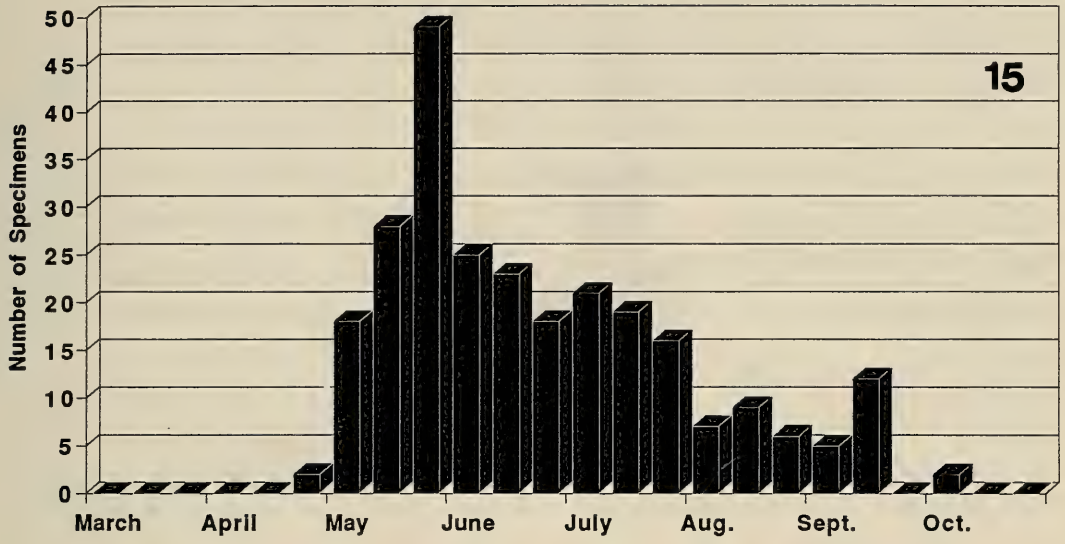
Townes (1950) separated two subspecies, the typical subspecies from northeastern United States and eastern Canada west to British Columbia, and *G. kirbii russeus* Townes from the Rocky Mountains west to the Pacific. The two were separated by the amount of orange on the abdomen, with *G. k. russeus* having the abdomen largely orange.

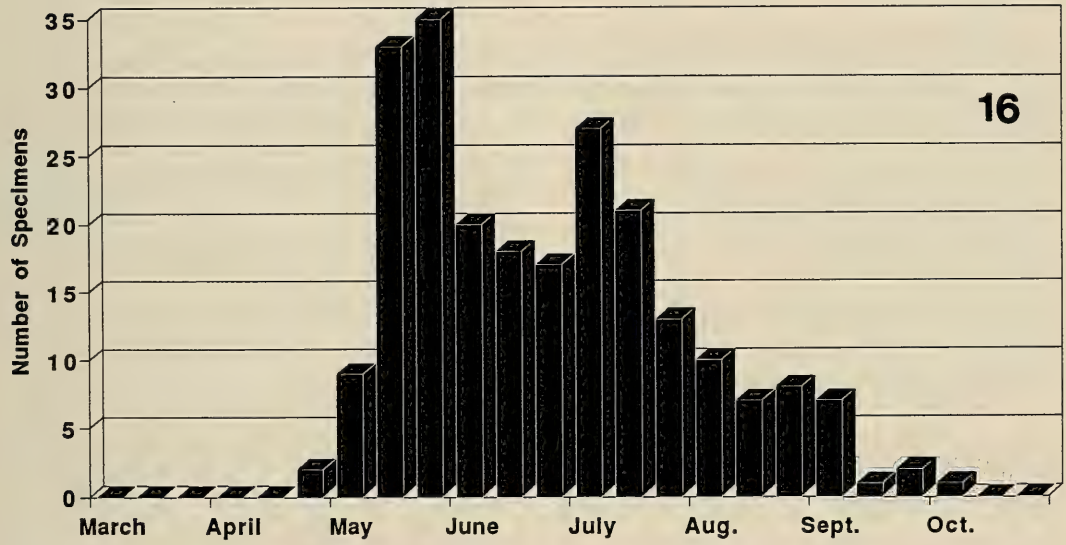
Diagnosis.—Very similar to *G. assectator* except for finer, more granular texture of the thorax (compare Figs. 5 and 6 with Fig. 2 and 3).

Distribution.—Nova Scotia to British Columbia, south to New York, Michigan, Colorado, California. Eastern North America: Michigan, New Brunswick, New York, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan.

Specimens examined.—None.

Hosts.—*Hylaeus modestus* Say (Colletidae), *Hoplitus sambuci* Titus (Megachilidae), and *Megachile rotundata* (F.) (= *M.*





Figs. 15–16. Seasonal occurrence. 15, *Gasteruption assectator.* 16, *G. floridanum.*

centuncularis (L.)) (Megachilidae) (Carlson, 1979).

Gasteruption tarsatorium (Say)
(Figs. 12–14, 17)

Townes (1950) recognized the typical subspecies from most of eastern North America and one other subspecies, *G. t. solaris* Townes, from Arizona and Kansas. *Gasteruption t. tarsatorium* is characterized by the presence of a pale spot at the hind corner of the pronotum and one on the underside of the scape, both of which are lacking in *G. t. solaris.*

Diagnosis.—Ovipositor sheath about to slightly more than 2× forewing length; tegula light reddish; mesonotal lateral lobe with some large, strong punctures; fore- and midtibiae with external white stripe from base to apex, or white basally and apically

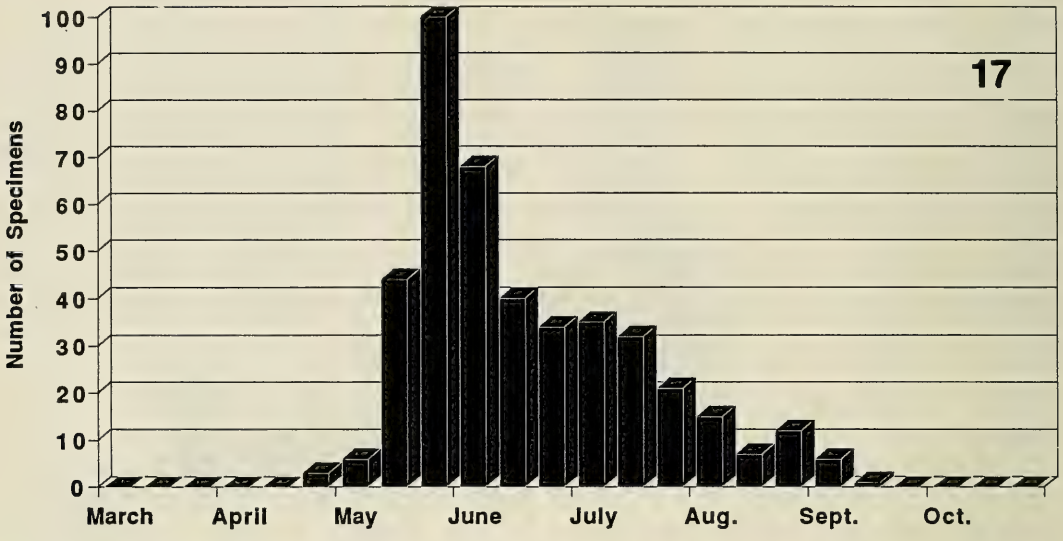


Fig. 17. Seasonal occurrence of *Gasteruption tarsatorium.*

with white areas elongate externally; propleuron without coarse transverse wrinkles; side of thorax finely punctate and dull between punctures and sculpture, densely hairy; posterior corner of pronotum and under side of scape commonly with dull-orange spot (males often black or with pale marks indistinct).

Distribution.—Arizona. Eastern North America: Connecticut, District of Columbia, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New York, North Carolina, New Hampshire, New Jersey, Ohio, Ontario, Pennsylvania, Quebec, South Carolina, Tennessee, Virginia.

Specimens examined.—Total: 425. MARYLAND: Allegany Co. 31.V–10.VI to 30.VII–8.VIII (9); Garrett Co. 10–19.VII and 29.VIII–7.IX (2); Prince George's Co. 5–18.V to 11–24.VII (29). VIRGINIA: Clarke Co. 26.IV–9.V to 26.VIII–11.IX (278); Essex Co. 22.IV–3.V to 17.IX–10.X (49); Fairfax Co. 6–12.V to 23–29.VII (10); Louisa Co. 1–11.V to 13–27.VII (48).

Host.—Reared from "climbing bittersweet" in Pennsylvania (Townes 1950). Rau (1922, 1928a) published two host records from Missouri. One specimen (Rau, 1922) was obtained from an elder twig at Meramec Highlands; other twigs in the same lot contained *Hypocrabro stirpicolus* (= *Ectemnius stirpicola* (Packard)) (Sphecidae), and he inferred that the wasp was its host. The other (Rau, 1928a) emerged from the nest of *Stenodynerus zendaloides* Robertson (= *Leptochilus ornatus* Saussure) (Vespidae). The latter is probably correct since there is one specimen of *G. tarsatorium* in the National Museum of Natural History labeled "Phil Rau, Rau no. 4439, St. Louis, Mo." and in the reprint of Rau's 1928a article is a handwritten note "Rau No. 4439 in USNM." The specimen and host from the elder twig can not be verified. Treherne (1916) recorded the host as "bees." Rau (1928b) recorded it from a nest of *Ceratina calcarata* Robertson (Anthophoridae). Krombein (1979) recorded *G. tarsatorium* as a parasite of *Leptochilus ornatus,* and Hurd (1979) listed *G. tarsatorium* as a parasite of *Ceratina calcarata,* both probably taken from Rau's publications.

According to data on specimen labels, adults have been collected from the following: flowers of *Rhus glabra* L.; on *Ceanothus americanus* L.; *Daucus carota* L.; and

Aruncus aruncus L. A specimen from Nebraska is labeled "ex gall on *Amorpha fruticosa.*"

Discussion.—Townes (1950) gave most records in July and August, with an early record of June 3 and late record of September 18. I have collected this species from the end of April through the first third of September (Fig. 17). The peak flight period is mid-May through the first third of June, and numbers drop off sharply beginning the end of July.

There are occasional reddish forms that appear in collections. These may have all or parts of the mesonotum, mesoscutellum, pronotum, and lower mesopleuron reddish, or various combinations or amounts of reddish. From collections of 425 specimens only 6 had some significant amounts of reddish on the thorax.

Acknowledgments

I thank E. M. Barrows, Georgetown University, Washington, D.C., for making available collections from the Tucker Co., Garrett Co., and Allegany Co. sites; Mr. and Mrs. J. G. Kloke, for field work on their properties in Louisa and Essex counties; M. Bowers, E. Connor, and C. Sacchi for allowing field work at the University of Virginia Blandy Experimental Farm and State Arboretum of Virginia, Clarke Co.; T. J. Henry and D. R. Miller for allowing collections of their properties in Hardy Co.; N. M. Schiff, Bee Research Laboratory, USDA, Beltsville, Maryland, and D. Barriner and T. Smith, summer assistants with the Systematic Entomology Laboratory, USDA, Beltsville, for assisting with collections. Terry Nuhn, Biological Laboratory Technician, Systematic Entomology Laboratory, USDA, took the photographs. I thank the following for reviewing the manuscript: S. Heydon, University of California, Davis; N. M. Schiff, Bee Research Laboratory, USDA, Beltsville, Maryland, and R. W. Poole and R. W. Hodges, Systematic Entomology Laboratory, USDA, Washington, D.C.

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SYNONYMIZING *SPILODERMUS* STÅL UNDER *PEIRATES* SERVILLE, AND REVISION OF THE RESULTING *P. QUADRINOTATUS* SPECIES GROUP (HETEROPTERA: REDUVIIDAE: PEIRATINAE)

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Abstract.—*Spilodermus* Stål is synonymized with *Peirates* Serville. Its species *P. argenteopilosus* Schouteden and *P. quadrinotatus* (Fabricius) (*Pirates arcuatus* Stål, **new synonymy** are assigned to the new *P. quadrinotatus* species group. These two species are redescribed, illustrated, their geographical distribution mapped, and a key for separating them is given. These species have an African-Indopacific distribution.

Key Words: Heteroptera, Reduviidae, *Peirates quadrinotatus* species group, *Peirates argenteopilosus, Peirates quadrinotatus*

Spilodermus Stål (1868) was originally described as a subgenus of *Peirates* Serville (1831) and contained the sole species *Reduvius quadrinotatus* Fabricius. This status was accepted by Dispons (1969), but valid generic standing was given by Villiers (1963) and Maldonado Capriles (1990).

The present synonymizing of *Spilodermus* as a junior synonym of *Peirates* transfers its three species to that genus where they form the new *quadrinotatus* species group, containing one new synonymy: *Peirates argenteopilosus* Schouteden, *Peirates quadrinotatus* (Fabricius) (= *Pirates arcuatus* Stål).

Material and Methods

The material examined belongs to the following institutions: American Museum of Natural History (AMNH), New York, USA; Bishop Museum (BPBM), Honolulu, USA; Deutsches Entomologisches Institut (DEI), Eberswalde, Germany; Instituut voor Taxonomische Zoölogie, Zoölogisch Museum, Universiteit van Amsterdam (ZMUA), Amsterdam, The Netherlands; Musée Royal de l'Afrique Centrale (MRAC), Tervuren, Belgium; Naturhistoriska Riksmuseet (NRS), Stockholm, Sweden; The Natural History Museum (BMNH), London, United Kingdom; Zoological Institute (ZIL), Saint Petersburg, Russia; and Zoological Museum (MZH), University of Helsinki, Helsinki, Finland.

The terminology used for the external morphology has been reported previously (Coscarón 1983, Lent and Jurberg 1966, Lent and Wygodzinsky 1979). The measurements and ratios, as seen in Table 1, were taken following Coscarón (1989). For this revision a total of four measurements and 11 ratios were selected. The terminology of the female genitalia has been detailed in Coscarón (1994). Extraction, dissection, inflation, and drawings of the male and female genitalia were performed according to Coscarón (1983).

Genus *Peirates* Serville

Peirates Serville 1831: 215. Type species: *Reduvius stridulus* Fabricius, designated by Blanchard 1846: 106.

Table 1. Measurements (ranges) and ratios studied for the *Peirates quadrinotatus* species group. Abbreviations: Tl—total length; WP—width pronotum; Wa—width abdomen; Hdl—head length; Hdh—head height; Aocl—length anteocular region; Pocl—length postocular region; Eyl—eye length; Eyw—eye width; Eyh—eye height; Eyio—length eye interocular region; oce—ocellar diameter; ant1–4—antennal segments 1–4 lengths; rosI–III—rostral segments I–III lengths; Pronl—pronotal anterior lobule length; PrPol—pronotal posterior lobule length.

Character	Sex	*Peirates* species	
		P. argenteopilosus	*P. quadrinotatus*
Tl	M	12.72–12.78	10.45–11.36
	F	11.36–11.65	9.09–11.45
Wp	M	3.18–3.35	2.72–3.09
	F	2.72–2.98	2.54–3.09
Wa	M	3.45–3.74	2.72–3.18
	F	3.18–3.31	2.90–3.27
Hdl/Hdh	M	1.00–1.04	0.90–1.25
	F	1.00–1.22	1.06–1.20
Aocl/Pocl	M	0.83–0.91	0.70–1.50
	F	1.00	0.75–1.50
Eyl/Eyw	M	1.00–1.31	1.00–1.20
	F	1.04–1.22	1.00–1.66
Eyh/Hdh	M	0.84–1.00	0.88–1.00
	F	0.84	0.80–0.87
Eyio/oce	M	0.90–0.92	0.61–0.77
	F	1.20–1.25	0.92–1.23
ant1/ant2	M	0.30–0.36	0.35–0.50
	F	0.41–0.50	0.40–0.45
ant1/ant3	M	0.28–0.38	0.34–0.40
	F	0.34–0.36	0.46
ant1/ant4	M	0.30–0.36	0.50
	F	0.30–0.33	0.50–0.65
rosI/rosII	M	0.61–0.67	0.48–0.52
	F	0.65–0.66	0.49–0.54
	M	0.71–0.79	0.81–0.85
	F	0.75–0.79	0.83–0.86
	M	3.09–3.36	2.36–2.90
rosI/rosIII	F	2.54–3.36	2.00–2.90
Pronl	M	1.14–1.40	1.15–1.66
PrAnl/PrPol	F	1.60–1.64	1.11–1.86

Pirates (*Spilodermus*) Stål 1868: 122. Type species: *Reduvius quadrinotatus* Fabricius, by monotypy. **New synonymy.**

Spilodermus Villiers 1963: 513; Maldonado Capriles 1990: 374.

Observations: Villier's (1948, 1963) suggestion of using the single autapomorphy, the acuminate scutellum, seems inadequate to validate this group as a genus or subgenus. This character allows the formation of a species group related with the *collarti* and *lepturoides* species groups of Coscarón and Morrone (1995).

The *Peirates quadrinotatus* Species Group (Figs. 1–24)

Diagnosis: Scutellum acuminated (Figs. 3, 15) and anterior pronotal lobe subrounded (Figs. 1, 13).

Description: Ocelli on a tubercle in the ♂ (Fig. 14), not on a tubercle in the ♀ (Fig. 2); anterior pronotal lobe subrounded (Figs. 1, 13), with light brown pilosity except in sulci, light brown hairs over surface and margins; sulci without granulations; scutellum acuminated (Figs. 3, 15); scutellum and most of body with reduced granulations over surface and edges; only macropterous form known; hemelytra surpassing apex of abdomen in the ♂, and not passing apex of abdomen in the ♀ (Fig. 1); connexivum exposed dorsally (Fig. 1); urosternites uniformly colored, tergites dark brown and whitish pilosity; last segment of abdomen dark brown. Male genitalia: medial process of pygophore straight (Figs. 6, 7, 18, 19); parameres subrectangular (Figs. 8, 9, 20, 21).

Key to Species of the *Peirates quadrinotatus* Species Group

– Hemelytra (Figs. 1, 4): corium brown except a whitish stripe between Pcu+ 1A and Cu; membrane with whitish band basally; pronotum anterior lobe reddish . . . . . .*Peirates argenteopilosus* (Schouteden)

– Hemelytra (Fig. 16): corium brown; membrane with one whitish spot apically; pronotum anterior lobe from brown to almost black . . . . . .*Peirates quadrinotatus* (Fabricius)

Peirates argenteopilosus Schouteden (Figs. 1–12)

Pirates argenteopilosus Schouteden 1931: 142; Villiers 1948: 235 (subgenus *Spilodermus*).

Spilodermus argenteopilosus: Villiers

1963: 513; Maldonado Capriles 1990: 374.

Male and *female* General aspect of female as seen Fig. 1. Head black, granulated, black pilosity. In lateral view (Fig. 2), eyes surpassing neither superior nor inferior edge of head. Antenna uniformly dark brown.

Pronotum anterior lobe reddish with dark brown tonalities, granulate. Sulci not distinct glabrous. Depression not distinct. Sutures undifferentiated. Posterior lobe reddish, with dark brown tonalities, with granulations and dark brown hairs. Scutellum, uniformly reddish, with dark brown hairs.

Predominating color dark brown, except for whitish stripe between Pcu+ 1A and Cu in corium, and two whitish bands in membrane, one basally and other distally. Pilosity white basally in clavus and corium.

Legs mostly dark brown, coxae distally, all hind, and base of mid and hind trochanter, base of femora yellowish; hind femur dark brown basally.

Pattern of connexivum as seen in Fig. 5. Urosternites 4–6 with a lateral whitish triangular pilose area.

Male genitalia (Figs. 6–9). Medial process of pygophore, ventral and lateral view as seen in Figs. 6 and 7, respectively. Parameres (Figs. 8, 9) with hairs.

Female genitalia (Figs. 10–12). Gonocoxites VIII and gonapophysis, gonocoxite IX, and IX and X tergites as seen in Figs. 10, 11 and 12, respectively. IX and X tergites (Fig. 12), intersegmental line not entire.

Measurements. See Table 1.

Distribution. Afrotropical. Angola, Cameroon, Guinea, Tanzania and Zaire (Fig. 25).

Material examined. Holotype ♀: Zaire, Uele, van Kerkhovinvelle Degreef R. Det. A. 2450 (MRAC); Paratype ♂: Angola, Benguela (Ddr. Wellmann), Coll. Schouteden, Det. A. 2450 (MRAC); Paratype ♂: Kenya, Lac. Tanganyka, Nyanza fin, XII-1932, L. Burgeon (MRAC); Paratype ♂: Zaire, Lulua, Kapanga, IV-IX-1958, J. Allaer (MRAC); Paratype ♂: Zaire, Uele, Dingila, 20-VII-1933, J. V. Leroy (MRAC); Paratype ♂: Zaire, Haut-Uele, Moto II-III-1923, L. Burgeon R. Det. A. 2450 (MRAC); Paratype ♂: Zaire, Haut-Uele, Moto IV-1926, L. Burgeon R. Det. B. 2450 (MRAC); Paratype ♂: Zaire, Haut-Uele, Moto IV-V-1923, L. Burgeon R. Det. A. 2450 (MRAC); Paratype ♂: Zaire, Haut-Uele, Moto L. Burgeon R. Det. A. 2450 (MRAC); Paratype ♂: Kasai Ishiluagi, 14-II-1932, G. F. Overlait, R. Det. C. 2450 (MRAC); Paratype ♂: Kindu, 24-XI-1911, Dr. Bequaert, R. Det. A. 2450 (MRAC); Paratype ♂: Beni à Lesse fin, VII-1911, Dr. Murtula, R. Det. A. 2450 (MRAC); Paratype ♂: Sankisia, 1911, Dr. Rodhain, R. Det. A. 2450 (MRAC); Paratype ♂: Kwamouth, VI-1921, Dr. H. Schouteden, R. Det. A. 2450 (MRAC); Paratype ♂: Rutshuru, II-1938, J. Ghesquière 6041 (MRAC); TANZANIA: Moba, 780 m (à la lumière), XI-1953, H. Bomans, ♂ (MRAC); Musoma, 980 m (à la lumière), XI-1953, H. Bomans, ♂ (MRAC); Moba, III-IX1953, H. Bomans, ♂ (MRAC). ZAIRE: P. N. G. Miss. H. de Saeger, 11/Fb/9, 5-III-1951, Réc. H. de Saeger. 1320, ♀ (MRAC); P. N. U., Georges de la Pelenge, 18-20-VI-1947, Miss. G. F. de Witte. 526a, ♀ (MRAC); P. N. G. Miss. H. de Saeger Mpaza/9, 23/I/1952, Réc. H. de Saeger. 3038, ♂ (MRAC); Lulua, Tshibamba, III-1933, F. G. Overlaet, ♀ (MRAC). Abessinia: Sekuala lac. Suai Fl. Dzallumaki, Manash, Sedov, ♂ 3-II-V-1903 (ZIL).

Peirates quadrinotatus (Fabricius)
(Figs. 13–24)

Reduvius 4-notatus Fabricius 1796: 544.

Peirates biguttatus Dohrn 1860: 407; synonymized by Stål 1868: 122.

Spilodermus quadrinotatus: Stål 1868: 122; Maldonado Capriles 1990: 374.

Pirates quadrinotatus: Walker 1873: 114.

Pirates (*Spilodermus*) *quadrinotatus:* Stål 1874: 58.

Pirates patricius Miller 1948: 444; synon-

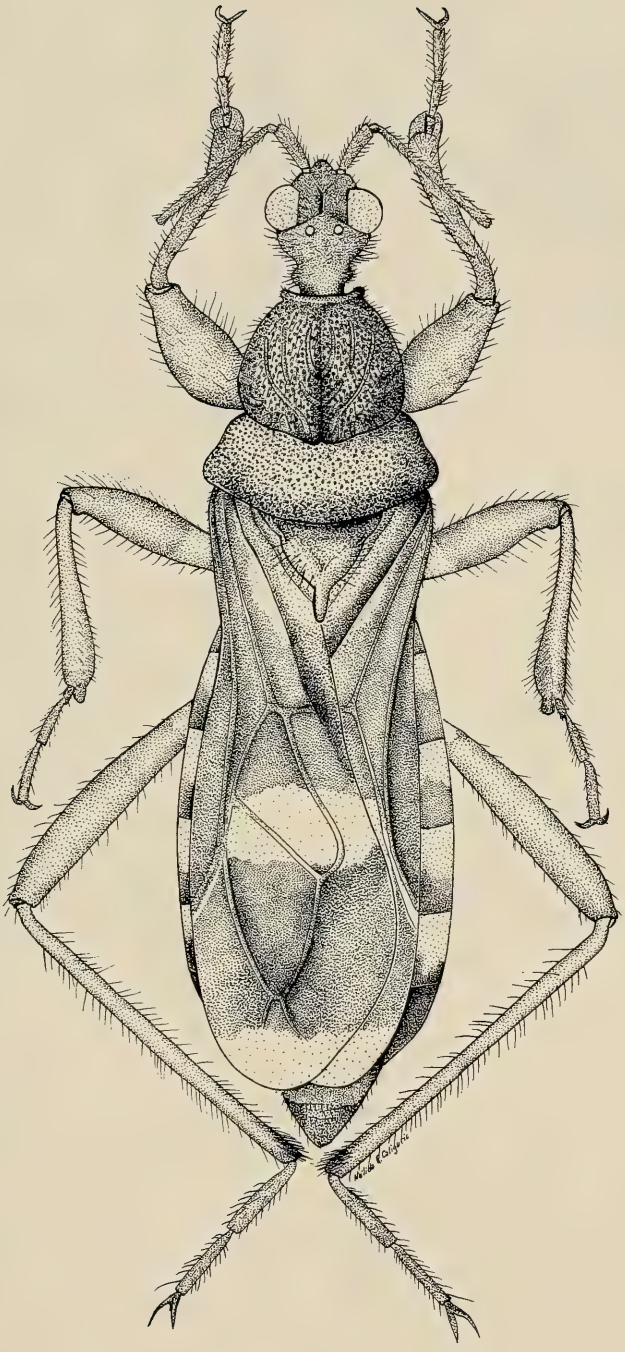
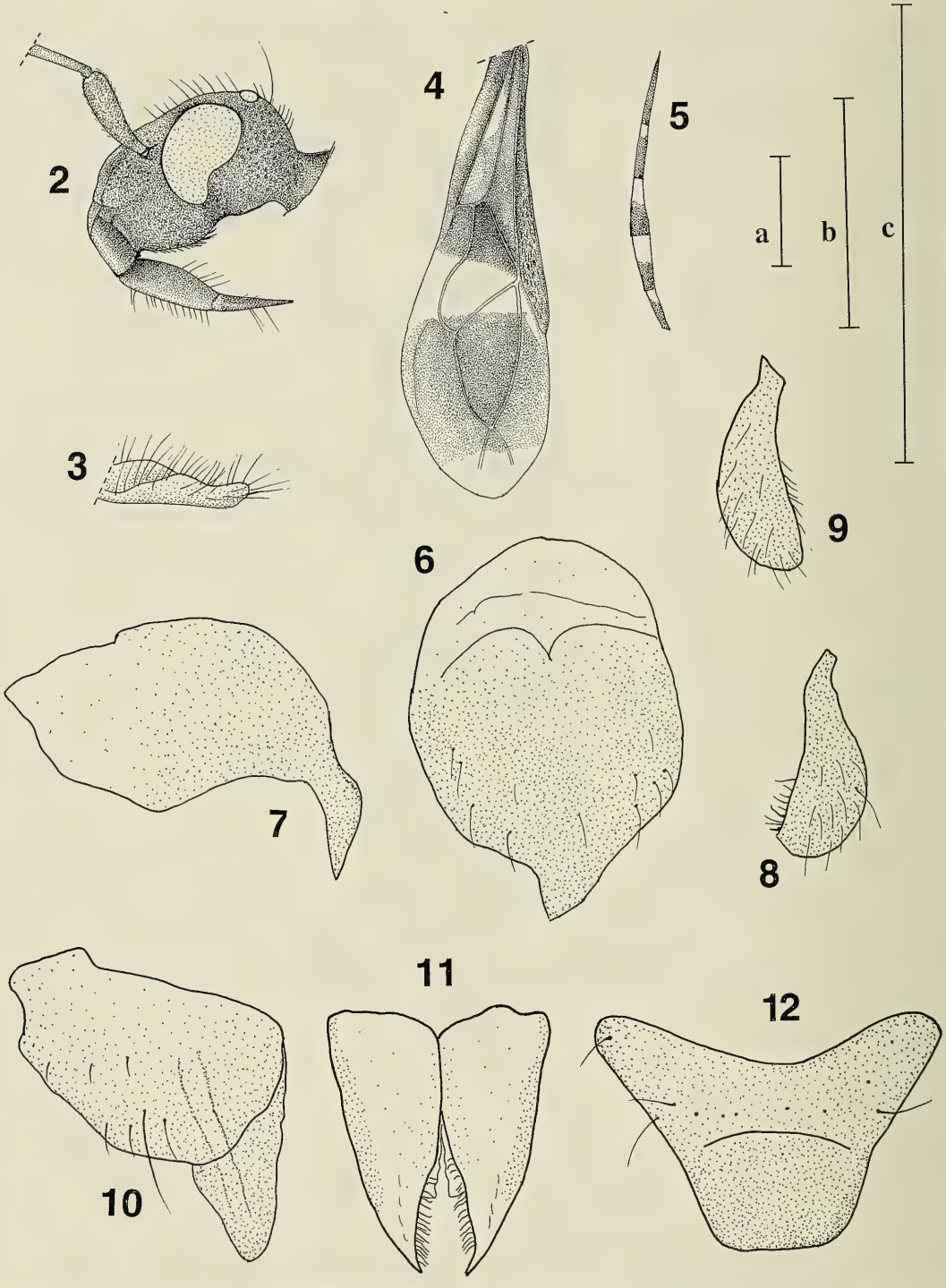


Fig. 1. *Peirates argenteopilosus,* dorsal view of female. Scale line = 2.0 mm.



Figs. 2–12. *Pierates argenteopilosus.* 2, Head, lateral view. 3, Scutellum, lateral view. 4, Hemelytron. 5, Connexivum. 6, Pygophore, ventral view. 7, Pygophore, lateral view. 8, Left paramere, external view. 9, Right paramere, external view. 10, Gonocoxite and gonapophysis VIII. 11, Gonocoxites IX. 12, IX and X tergites. Scale lines = 2.0 mm: (a) for Figs. 4, 5; (b) for Figs. 2, 3; and (c) for Figs. 6–12.

ymized by Dispons 1969: 7 with *Pirates* (*Spilodermus*) *arcuatus.*

Peirates patricius: Maldonado Capriles 1990: 365.

Pirates picturatus Miller 1948: 444; synonymized by Dispons 1969: 7 with *Pirates* (*Spilodermus*) *arcuatus.*

Peirates picturatus: Maldonado Capriles 1990: 365.

Pirates arcuatus Stål 1870: 692. **New synonymy.**

Pirates (*Spilodermus*) *arcuatus:* Stål 1874: 58; synonymized by Kiritshenko 1961: 444 with *Ectomocoris flavomaculatus.*

Pirates mutilloides sic Walker 1873: 120; synonymized by Distant 1902: 288 with *P. arcuatus.*

Male and *female.* Head dark brown, almost black, not granulated, whitish pilosity. In lateral view (Fig. 14), eyes surpassing superior but not inferior edge of head. Antenna uniformly dark brown, except base first antennal segment yellowish.

Pronotum anterior lobe brownish with dark brown tonalities, not granulate. Sulci distinct, with whitish to light brown pilosity, and light brown hairs. Depression distinct. Lateral internal sulci medially united and extending to transversal sulci, medial sulci divided in two and attaining transversal sulci, and lateral external sulci attaining transversal sulci. Posterior lobe brownish, with dark brown tonalities, without granulations and light brown hairs. Scutellum not uniformly brownish, with dark brown tonalities, and light brown hairs.

Predominating color dark brown in membrane and part of corium, except a whitish stripe and a spot in membrane. Clavus brown, except basal zone with orange tonalities. Corium, area between Pcu+ 1A and Cu brown, and Cu and SC brown with orange tonalities (in some specimens more noticeably). Pilosity at base of clavus and corium dark brown.

Legs dark brown, except yellowish distal end of coxae, base of mid and hind trochanter, base of mid and hind femur.

Pattern of connexivum as seen in Figure 17.

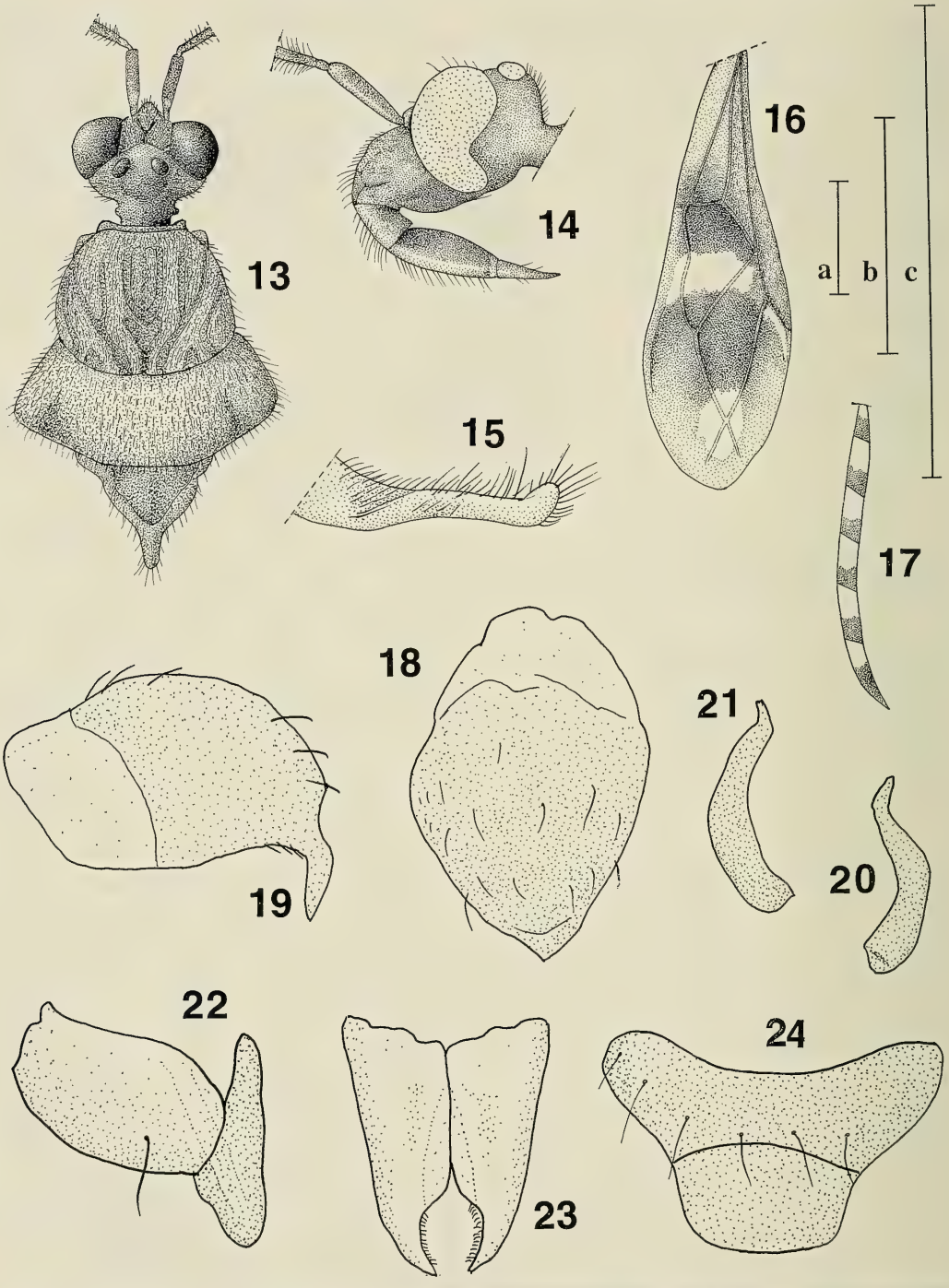
Male genitalia (Figs. 18–21). Medial process of pygophore, ventral and lateral view as seen in Figs. 18 and 19, respectively. Parameres (Figs. 20, 21), without hairs.

Female genitalia (Figs. 22–24). Gonocoxites VIII and gonapophysis, gonocoxite IX, and IX and X tergites as seen in Figs. 22, 23 and 24, respectively. IX and X tergites (Fig. 24), intersegmental line entire.

Measurements. See Table 1.

Distribution. Indomalayian and Paleartic. Bangladesh, Burma, China, Hong Kong, India, Japan, Java, Laos, Philippines, Sri Lanka and Sumatra (Fig. 25).

Material examined. Type ♀: Sud Java, Coll Breddin, *Pirates picturatus* sp. n., det. N. C. E. Miller 1939 (DEI). Type ♀: Sumatra, *Pirates patricius* sp. n., det. N. C. E. Miller 1939 (DEI). Type ♀: Philippines, Insulae Philippinae, Semper, *Spilodermus arcuatus* Stål (NRS); Allotype ♂: Philippines, Insulae Philippinae, Semper (NRS). Paratype ♀: Sumatra, *Pirates patricius* sp. paratype det. N. C. E. Miller 1939 (BMNH). BANGLADESH: Silhet, ♀ (NRS). BURMA: Teinzo, Fea Maggio, ♂ 1866 (ZIL). INDIA: Anamalai Hills Cinchona, 3500 ft, V-1969, P. S. Nathan, ♀ (ZMUA); New Delhi, 1-10-VIII-1958, Anekeandpoß, ♂ (ZIL); Dobhalwalla, 2304 ft, Dehra Dun, I., X-XI-1945, Jai K. Uniyal, ♀ (AMNH); Kashmir, ♂ (NRS). JAVA: Banjoewangi, Lucht, 1930, ♀, 2♂♂ (ZIL); Banjoewangi, Lucht, XII-1931-II-1932, ♀, 2♂♂ (ZIL); Banjoewangi, Lucht, without abdomen (ZIL); Tranquebar Urstermann, ♂ (NRS); Jjkarang Djampang, from M. E. Walsh, ♀, 2♂♂ XII-1938 (BPBM). LAOS: Sayaboury, Prov. Sayaboury, ♂ 31-XII-1965, native collector Bishop Museum (BPBM); Sayaboury, Prov. Sayaboury, ♀ 21-IV-1966, native collector Bishop Museum (BPBM). PHILIPPINES: Los Banos, Ids., ♀ VIII-1916, F. X. Williams col. (BPBM); Los Banos, P. I. Baker, without abdomen (AMNH); Mt. Makiling Luzon, Baker col., ♂



FIGS. 13–24. *Peirates quadrinotatus.* 13, Head, pronotum, and scutellum, dorsal view. 14, Head, lateral view. 15, Scutellum, lateral view. 16, Hemelytron. 17, Connexivum. 18, Pygophore, ventral view. 19, Pygophore, lateral view. 20, Left paramere, external view. 21, Right paramere, external view. 22, Gonocoxite and gonapophysis VIII. 23, Gonocoxites IX. 24, IX and X tergites. Scale lines = 2.0 mm: (a) for Figs. 17, 17; (b) for Figs. 13–15; and (c) for Figs. 18–24.

FIG. 25. Distribution of *Peirates argenteopilosus* (black circles) and *P. quadrinotatus* (open circles).

(AMNH); Mt. Makiling Luzon, Baker col., without abdomen (AMNH); Davan Mindanan Baker, without abdomen (AMNH); Mindanao, Mis. Or. Mt. Pomalihi 21 km W Gingoog City, 800–1000 m, 17-IX-1965, H. M. Torrevillas, col. Bishop Museum, ♀ (BPBM). SRI LANKA: (Lewis); Distant col. 1911: 383 (BMNH) *picturatus* BMNH, ♀, nymph (BMNH). WITHOUT COUNTRY: Carin As civii Ghecù, 1400–1500 m, L. Fea, ♂ III-IV-1988, 245 (ZIL).

Observations. P. arcuatus and *P. quadrinotatus* differ by the different color of the anterior lobule of the pronotum only, so we consider them synonyms.

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THAUMATOMYIA ELONGATULA (BECKER) (CHLOROPIDAE) AND *LEUCOPIS ANNULIPES* ZETTERSTEDT (CHAMAEMYIIDAE): TWO DIPTERA PREYING ON *PHLOEOMYZUS PASSERINII* (SIGNORET) (HOMOPTERA: PHLOEOMYZIDAE) IN ITALY

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Abstract.—A report is made of the discovery of *Thaumatomyia elongatula* (Becker) (Diptera: Chloropidae) and *Leucopis annulipes* Zetterstedt (Diptera: Chamaemyiidae) in coastal central Tuscany preying on the aphid *Phloeomyzus passerinii* (Signoret) (Homoptera: Phloeomyzidae) that attacks the trunk and branches of poplar trees. The biology *of Thaumatomyia elongatula* was previously unknown. To date this species is the only chloropid of the genus *Thaumatomyia* found feeding on aphids living on tree trunks and branches. All other *Thaumatomyia* species feed only on Pemphigidae that live on plant roots. A brief description of terminalia, third instar larvae and puparia of *Thaumatomyia elongatula* and *Leucopis annulipes* is also given here.

Key Words: Diptera, Chloropidae, Chamaemyiidae, *Thaumatomyia, Leucopis,* aphid predators.

Chloropidae larvae have varied food habits. Most are phytophagous or saprophagous, but some are predaceous such as those of the genus *Thaumatomyia* Zenker (Sabrosky 1987). *Thaumatomyia* larvae were long considered phytophagous, but as early as 1918 Parker showed that *Chloropisca* (= *Thaumatomyia*) *glabra* Meigen was the most effective insect enemy in Montana of *Pemphigus betae* Doane that infests the roots of sugar beet. Subsequently many authors in America, Europe and Asia showed that species of the genus *Thaumatomyia* prey on various species of Pemphigidae infesting the roots of cultivated and wild plants (Mesnil 1933, Balachowsky and Mesnil 1935, Aczél 1940, Dunn 1960, Harper 1963, Minoranskii 1966, Kamalov 1974, Petrukka and Gres' 1974, Yarkulov 1975, Grigorov 1977, Alleyne and Morrison 1978, Fedorenko 1985, Summers and Newton 1989). Only Andersson (1977) reports that the larvae of *Thaumatomyia* species "prey on root-living aphids and coccids."

This report is the first record of *Thaumatomyia elongatula* (Becker) preying commonly on *Phloeomyzus passerinii* (Signoret) (Homoptera: Phloeomyzidae), which lives in cracks of poplar tree bark and attacks the trunk and branches of poplar. On the same host and in the same period I also found the larvae of *Leucopis annulipes* Zetterstedt (Diptera: Chamaemyiidae). It is known that Chamaemyiidae larvae prey on Aphidoidea and/or some groups of Coccoidea (Tanasijtshuk 1986, McAlpine 1987, Raspi 1990, Raspi and Bertolini 1993).

Phloeomyzus passerinii is known from Great Britain, France, Spain, Morocco, Egypt, Italy, Germany, Russia, and Pakistan and lives on several species of *Populus* sp.,

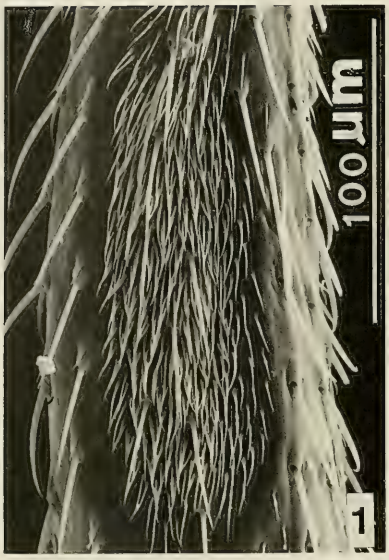


Fig. 1. *Thaumatomyia elongatula,* tibial organ, located on the posterodorsal side of hind tibia.

including *Populus alba* L., *P. nigra* L., and *P. canadensis* Moench. In Italy this aphid usually develops anholocyclically as apterous virginoparous females. It completes 12 generations per year in the field and overwinters as a neanid (Arzone and Vidano 1984). *Phloeomyzus passerinii* is located in the cracks of poplar bark and attacks the trunk, branches and emerging roots of poplar trees. In heavy infestations the trunk and branches of poplar trees appear covered by waxen threads produced by the aphid.

Thaumatomyia elongatula (Becker), 1910

Taxonomy

Species now in the genus *Thaumatomyia* Zenker 1833 were originally described in *Chloropisca* Loew 1866. Sabrosky (1943) was the first to synonymize *Chloropisca,* and subsequent authors have followed his synonymy. Andersson (1977) considered *Chloropisca* as a subgenus of *Thaumatomyia,* but confirmed that the differences are small and that the male genitalia of *Chloropisca glabra* (Meigen) are well within the range of variation of *Thaumatomyia* (s. str.) species.

Becker (1910) based his description of *Thaumatomyia elongatula* on one specimen in the Bezzi collection collected at Sondrio (Italy) and one specimen from Corsica in Schnuse's collection. It is worth mentioning that the specimen of *Chloropisca elongatula* from Sondrio (6/IX/99), a male, is in the Bezzi Collection of the Museum of Natural History in Milan.

Distribution

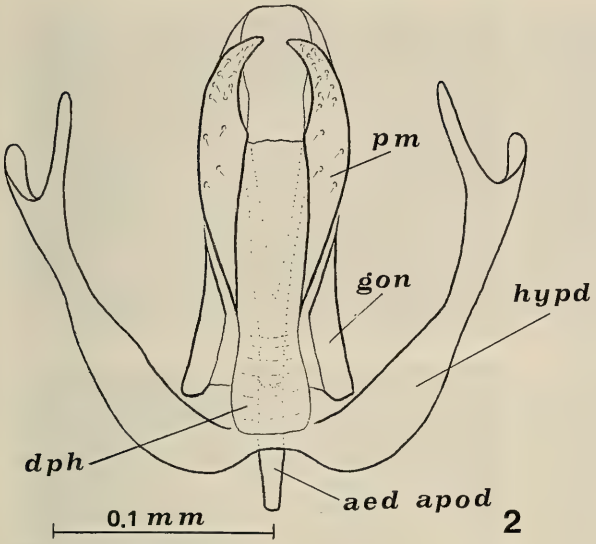
This species has been reported from France, Italy, Austria, Hungary, Germany, Russia, Ukraine, Moldavia (Becker 1910, Duda 1933, Nartshuk 1984). Its hosts were unknown until now.

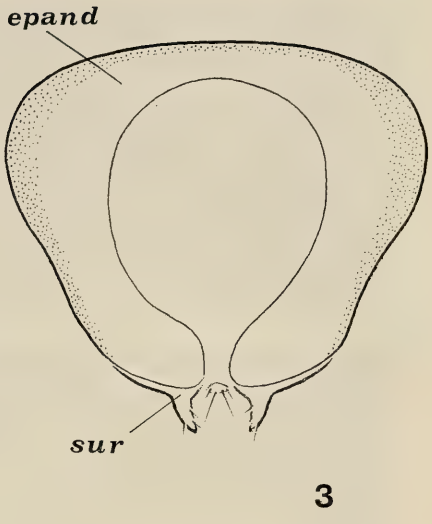
Description

Adult.—Length about 2.3 mm. Characterized by the shape of the third antennal segment that is longer than wide. A large, elongate oval area with dense short hairs (called tibial organ) is present on posterodorsal side of hind tibia (Fig. 1). For more certain identification a description of male terminalia is given for the first time.

Hypandrium parabolic in ventral view, with wide bend at top. Aedeagus almost cylindrical with long distiphallus reaching hypandrium. Subtriangular parameres narrow and extend more than half-way down aedeagus, with numerous small bristles. Gonopods almost triangular and short (Fig. 2). Male terminalia also characterized by epandrium that is subtrapezoidal with dorsal part 1.8 times as wide as basal part, and middle lobe of surstyli with hook-shaped apex (Fig. 3).

Third instar larva.—Facial mask characterized by smooth oral lobes, without oral ridges. Integument of full-grown larvae (about 4.5–5 × 0.8 in size) smooth, with lines of small spicules present only ventrally; whitish pale yellow and transparent, allowing the greenish gut to be seen. Anterior spiracles fan-shaped with seven digits. Posterior spiracles smooth, cone-shaped, as long as the base is wide, each with three elongate lobes at top with a lon-





Figs. 2, 3. *Thaumatomyia elongatula.* 2, Male terminalia in ventral view. 3, Schematic outline of the epandrium in posterior view. Abbreviations: dph = distiphallus, epand = epandrium, gon = gonopod, hypd = hypandrium pm = paramere, sur = surstylus.

gitudinal apical opening. Cephalopharyngeal skeleton (Fig. 4) (length 0.3 mm) black and brown, with strong mouth hooks, and a hooked portion with an accessory tooth and more sclerotized base of roughly rectangular shape. Hypopharyngeal sclerite H-shaped with a strong ventral bridge and not fused with tentoropharyngeal sclerite; a pair of slender sclerotized rods (parastomal bars) present above the hypopharyngeal

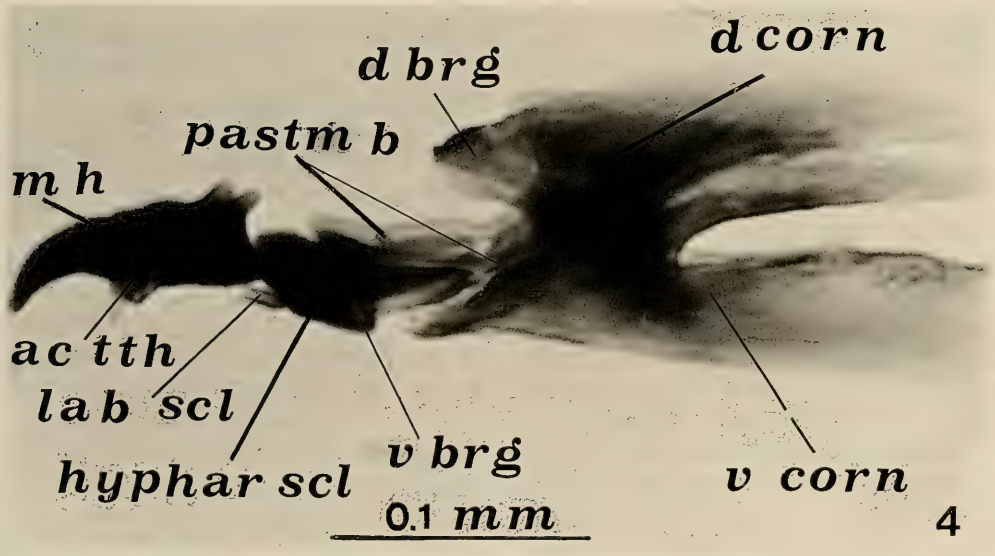
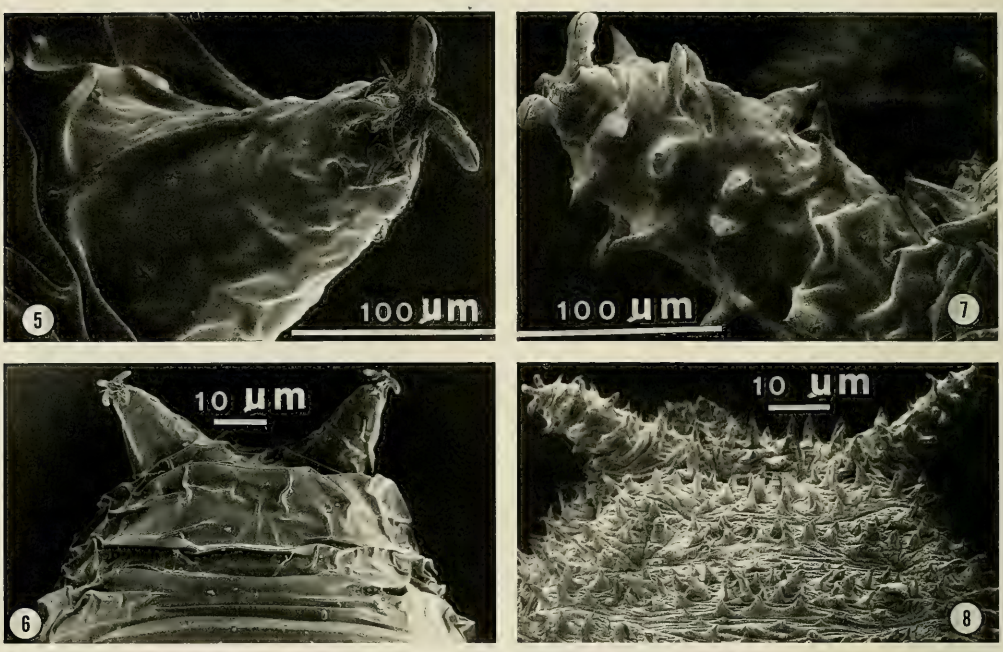


Fig. 4. *Thaumatomyia elongatula,* cephalopharyngeal skeleton. Abbreviations: ac tth = accessory tooth, d brg = dorsal bridge, d corn = dorsal cornu, hyphar scl = hypopharyngeal sclerite, lab scl = labial sclerite, m h = mouth hook, pastm b = parastomal bar, v brg = ventral bridge, v corn = ventral cornu.



Figs. 5–8. 5, *Thaumatomyia elongatula,* detail of posterior spiracular process (in puparium) bearing at apex three elongate spiracular lobes. 6, *T. elongatula,* posterior part of puparium with two characteristic smooth spiracular protuberances. 7, *Leucopis annulipes,* detail of posterior spiracular process (in puparium) bearing at apex three reniform spiracular lobes. 8, *L. annulipes.* Posterior part of puparium with two characteristic spiracular protuberances.

sclerite. Tentoropharyngeal sclerite weakly sclerotized and joined anterodorsally with prominent dorsal bridge.

Puparium.—(Figs. 5, 6) (size about 2.8 × 0.9 mm). Creamy light-brown and surface characterized by transverse folds of integument. The two characteristic posterior spiracular protuberances of the third instar are clearly visible.

Biology

In the coastal area of the province of Pisa, in 1990–1993, poplar groves (in particular the hybrid *Populus* × *euramericana* (Dode) Guinier I-214), as well as old isolated poplars in urban plantations were occasionally found to be strongly infested by the *P. passerinii.* From the beginning of June the trunk and branches of poplar trees were covered by waxen threads produced by the aphid. At this time, many different predators such as Syrphidae and Coccinellidae were present in bark cracks among the aphid colonies. Arzone (1987) has reported about 30 species of predators of *Phloemyzus passerinii* and among these, a *Thaumatomyia* (*Chloropisca*) sp.

Thaumatomyia elongatula adults were present from the beginning of June, resting on poplar tree trunks during the period when the population of *Phloeomyzus passerinii* is at greatest density. The white eggs (about 0.5 mm in length), of *T. elongatula,* are laid singly on the edge of cracks in the trunk and branches. Larval feeding habits are similar to those of aphidiphagous Syrphidae and Chamaemyiidae larvae, with the difference that *T. elongatula* larvae feed on aphids by slipping into grooves of the bark where aphids are found. Puparia can be found sticking to an outgrowth of bark, near the crack in the trunk where the larvae last fed or in the outgrowth at the base of the insertion of branches. Adults emerge from

puparia until mid July, after which one no longer finds *T. elongatula* larvae, puparia or adults. This coincides with the fall in density of the *P. passerinii* population. In the area studied, the fall in aphid population is very probably related to climatic conditions (high temperature and low humidity) and the action of the numerous entomophages.

Leucopis annulipes Zetterstedt, 1848

Taxonomy

McAlpine (1967) redescribed *L. annulipes,* discussed its identity and designated a lectotype.

Distribution and Hosts

Leucopis annulipes is widespread in Europe and Asia (Tanasijtshuk 1986) and has been recorded from Sweden, Poland, France, Italy (Raspi 1995), Hungary, Bulgaria, Russia, Ukraine, Moldavia, Georgia, Armenia, Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan, Kirghizia and Iran. *Leucopis annulipes* is also widespread in Italy and in particular is very common on the host *Phloeomyzus passerinii.* Many specimens are present in some collections but frequently wrongly identified.

Leucopis annulipes larvae are polyphagous and prey on aphids as reported by Tanasijtshuk (1986), in particular on many genera of Aphididae and also Chaitophoridae (*Chaitophorus niger* Mordvilko), Pemphigidae (*Eriosoma lanigerum* (Hausmann)), and Phloeomyzidae (*Phloeomyzus passerinii*).

Description

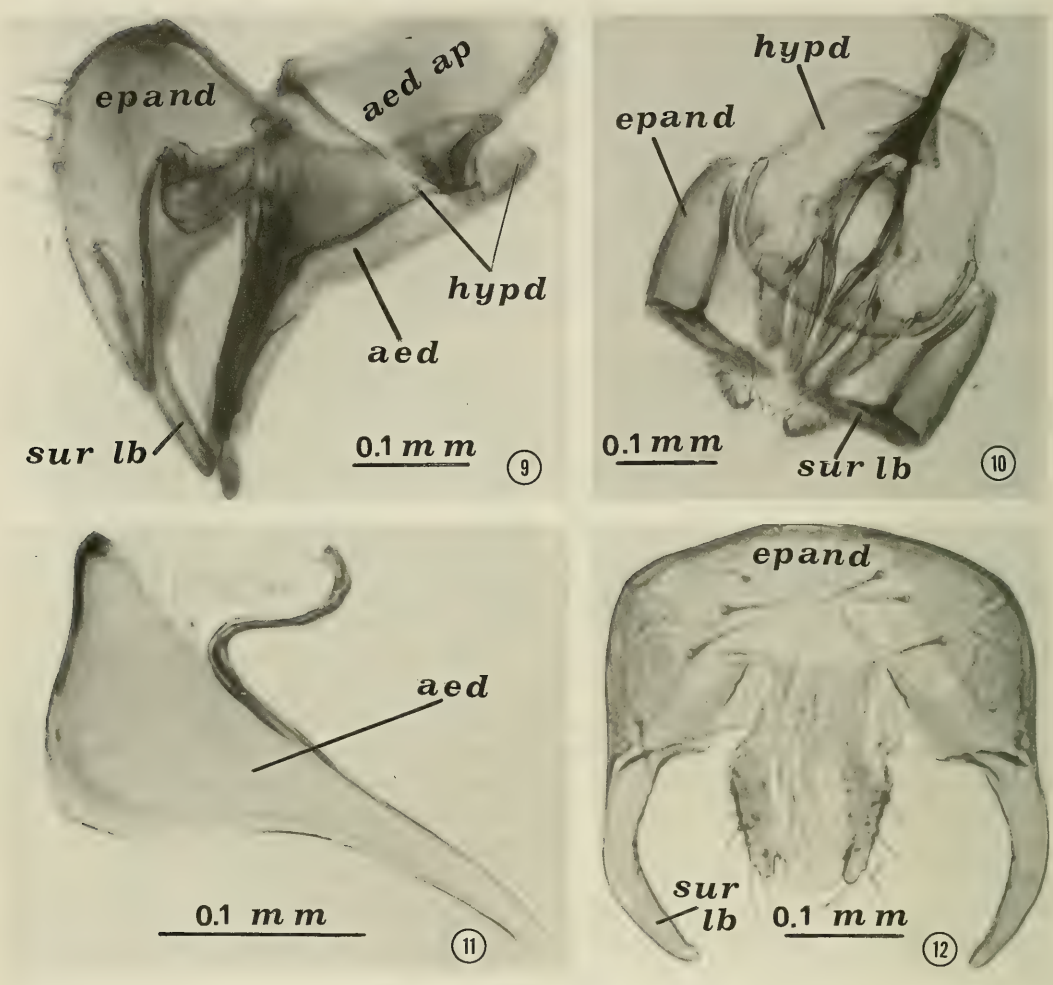
Adult.—Length about 2.5 mm. Generally silvery grey, with blackish antennae and palpi. Male frons with prominent, characteristic, felty pad enclosing anterior ocellus. McAlpine (1967) made a careful description of the male lectotype of *L. annulipes* and made drawings of the head, thorax, abdomen and male terminalia. Both sexes are generally similar, but the ocellar triangle is less prominent in the female. Only the study of male and female terminalia, however, makes it possible to identify this species with certainty. To insure correct identification of *L. annulipes,* a brief description of male and, for the first time, female terminalia is given here.

Male terminalia (Figs. 9–12) characterized by a compressed aedeagus, compact in lateral view. From base to midlength, aedeagus fairly wide, then narrows and curves slightly downwards to end in a pointed tip (Fig. 11). Epandrium and surstylar lobes with very distinctive shape; long and narrow in lateral view and strongly inwardly curving from posterior and ventral view (Figs. 9, 10, 12).

Ovipositor relatively short (Figs. 13–14). Sixth sternite large, of approximately rectangular shape, with base 2.3 times as wide as high and with numerous setulae in second half of sternite; this sternite appears much less heavily sclerotized in marginal areas of first half of sternite. Lateral margin of sixth tergite sinuous. Base of sixth sternite 1.5 times as wide as base of fifth. Fifth sternite almost trapezoidal with numerous setulae distributed roughly along three lines parallel to base; this sternite appears much less heavily sclerotized in marginal areas. Seventh sternum with two small, variably-shaped, but frequently almost equilaterally triangular sclerites with one apex turned distally. Seventh tergum membranous. Tergum of eighth segment only weakly sclerotized. Two pairs of strongly sclerotized spherical spermathecae present.

The shape of the surstylar lobes and the frons of the male with its prominent felty pad are the two most important characteristics of this species, together with the larval morphology. Rondani (1847) was first to note that adults of *Leucopis* species are very similar and that larvae are important for discrimination among species.

Third instar larva.—Facial mask characterized by smooth oral lobes. Full-grown larva (size about 4.2–4.5 × 1.1) whitish-pink and transparent, with dark gut visible. Integument, dorso-laterally, presents numerous spines that are short and flat at their



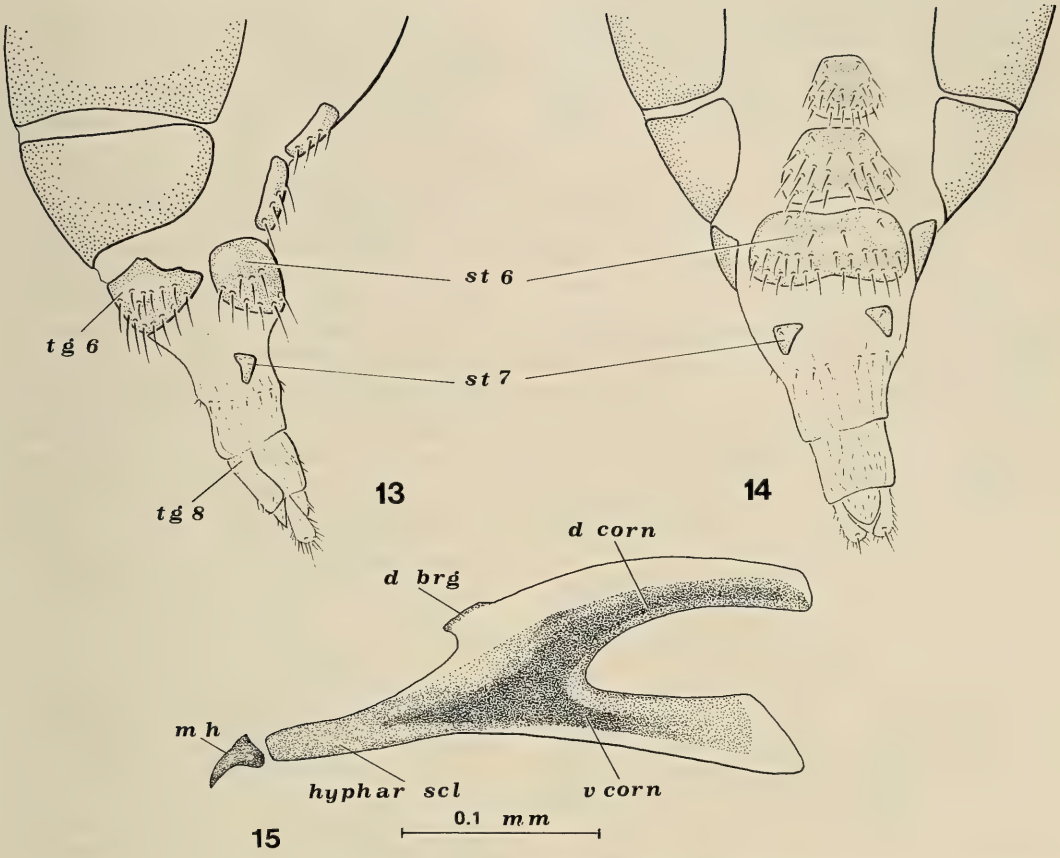
Figs. 9–12. *Leucopis annulipes*. 9, Microphotograph of male terminalia in lateral view. 10, Microphotograph of male terminalia in ventral view. 11, Aedeagus in lateral view. 12, Epandrium in posterior view. Abbreviations: aed = aedeagus, aed apod = aedeagal apodeme, epand = epandrium, hypd = hypandrium, sur lb = surstylar lobe.

base and very small ventrally. Anterior spiracles usually with four digits. Posterior spiracular protuberances typically surrounded by about four lines of spines, each spiracle characterized by three reniform lobes with a longitudinal apical opening. Cephalopharyngeal skeleton (Fig. 15) (length about 0.3 mm) black and brown, with small mouthhooks; hypopharyngeal sclerite elongate, weakly sclerotized, and fused with tentoropharyngeal sclerite. Hypopharyngeal bridge membranous. Tentoropharyngeal sclerite strongly sclerotized only centrally and in dorsal cornua, and joined anterodorsally with a prominent, weakly sclerotized dorsal bridge.

Puparium.—Figs. 7, 8 (Size about 2.4–3.6 × 0.9–1.2) reddish brown and similar in shape to larva, but body slightly flattened, with two longitudinal laterodorsal prominent ridges.

Biology

In the coastal area of Tuscany (province of Pisa), poplar groves, as well as old isolated poplar trees in urban plantations, were



Figs. 13–15. *Leucopis annulipes.* 13, Female teminalia in lateral view. 14, Female terminalia in ventral view. Abbreviations: st = sternite, tg = tergite. 15, Cephalopharyngeal skeleton. Abbreviations: d corn = dorsal cornu, hyphar scl = hypopharyngeal sclerite, m h = mouth hook, v corn = ventral cornu.

sometimes found to be strongly infested by *P. passerinii. Leucopis annulipes* larvae were commonly found on trunks among aphid colonies. Puparia can be found sticking to an outgrowth of bark, near the crack in the trunk where the larvae last fed. Adults emerge from puparia until mid July, after which, it is no longer possible to find *L. annulipes* on the host in the area studied.

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A REVIEW OF *BEMBECINUS* (HYMENOPTERA: SPHECIDAE: STIZINI) IN NORTH AND CENTRAL AMERICA

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Abstract.—The 11 species of *Bembecinus* occurring in America north of the Panama Canal are keyed, their synonymy shown, and critical structures figured. Two new species are described: ***B. clypearis*** (Arizona; New Mexico; Sonora, Mexico), and ***B. ater*** (Arizona, Mexico). Two subspecies are elevated to species status: *B. floridanus* Krombein and Willink, and *B. strenuus* Mickel. A twelfth species, *B. moneduloides* F. Smith, recorded once from Florida, is treated as an exotic species, the original locality citation in error. A lectotype is designated for *B. moneduloides* and for *B. nanus.*

Key Words: *Bembecinus,* Sphecidae, Stizini, North America, Central America

The genus *Bembecinus* A. Costa (1859, type species *B. meridionalis* A. Costa) occurs in all of the world's Zoological Regions. The most complete general treatment was that of Bohart and Menke (1976). Of the more than 150 known species only about 30 occur in the New World, and only 11 of these in North and Central America. All of ours belong to a group exemplified by the Eurasian *tridens* (Fabricius). In members of this group the male flagellar article IX is produced ventrally into a "spine" consisting of several adherent setae (Fig. 13). This contrasts with many species in the Ethiopian Region that have simple male antennae.

As a member of the Sphecidae (Nyssoninae), *Bembecinus* of America can be distinguished by the sessile abdomen, three well-formed ocelli, three forewing submarginal cells, hindwing median cell with only one appendage, propodeum laterally extended flange-like, no episternal-scrobal sulcus, male flagellomere IX with a ventral spine-like projection (Fig. 13), and male S-VIII triramose (Fig. 11).

Species of *Bembecinus* have frequently been described in other genera: *Vespa, Stizus, Larra, Bembidula, Stizolarra, Monedula, Nysson, Crabro,* and *Mellinus.* It wasn't until J. Parker (1929) that workers recognized the generic validity of *Bembecinus.*

An outstanding early work on the subfamily Nyssoninae (including *Bembecinus*) was by Handlirsch (1887–1895, esp. 1892). More modern authors, who have contributed to the New World fauna, are Willink (1949, 1957) and Krombein and Willink (1951). Others who described species which occur in the area north of Panama were F. Smith (1856, 1873), Saussure (1892), Cresson (1872), Say (1823), Cameron (1888–1900, 1904), Cockerell (1898), and Mickel (1918).

An asterisk before a name indicates that a primary type has been seen.

The existence of xanthochroism in males of some species has led to considerable synonymy. Four of the 11 species considered here exhibit this condition, and it is always or nearly always present in *clypearis* and *neglectus.* Dark males are common in the other two (*mexicanus* and *quinquespino-*

sus). Krombein and Willink (1951) discussed xanthochroism at some length.

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Terms or abbreviations which may be unfamiliar: UA, upper angle or convexity of propodeal flange; LA, lower lateral angle or projection of propodeum; MOD, median ocellus diameter; T-I to VII, terga; S-I to VIII, sterna; LID, least interocular distance.

Key to Bembecinus of North and Central America

1. UA broadly rounded as seen laterally; if outline is somewhat uneven, then irregularity is quite small or obtuse (Figs. 3, 4, 9); longer hairs laterally on last abdominal segment pale 2
– UA projecting in lateral outline (Figs. 5, 6, 7, 10), or even forming a sharp notch between UA and LA (Fig. 8), longer hairs laterally on last abdominal segment various 5
2. Male extensively yellow, T-VII narrowed before apex which is not notched (Fig. 16); female clypeus whitish yellow toward apex, grading up to yellow toward base; tergal bands whitish in both sexes . . . . . *clypearis* Bohart, new species
– Male not extensively yellow, T-VII not much narrowed before apex which is notched (Fig. 15); female clypeus not grading from whitish yellow to yellow 3
3. Mandible black toward base, clypeus all or nearly all black in both sexes, supraclypeal area all black . . . . . *ater* Bohart, new species
– Mandible yellow or whitish toward base, clypeus yellow (male) or with lateral pale spots (female) sometimes joined medially, supraclypeal area not all black 4
4. Propodeal flange UA (in lateral view) definitely protruding, hindfemur in females and nearly all males marked with red distally. . . . . *bishoppi* Krombein and Willink
– Propodeal flange UA (in lateral view) smoothly and obtusely rounded, hindfemur black but narrowly whitish yellow distally . . . . . *wheeleri* Krombein and Willink
5. Last two abdominal segments with outstanding hairs black 6
– Last two abdominal segments with outstanding hairs whitish or fulvous; if black on last segment, not so on penultimate. 8
6. Tergal bands deep yellow, including T-V, tibiae wholly yellow or nearly so, clypeus mostly or all yellow, sterna with lateral yellow spots on more than one segment, female forebasitarsus all yellow . . . . . *nanus* (Handlirsch)
– Tergal bands light yellow or nearly white, tibiae with considerable black beneath, sternal spots and clypeus various, female forebasitarsus black bordered 7
7. Clypeus of female all black, penultimate tergum with whitish band, S-II to IV usually with lateral whitish spots . . . . . *floridanus* Krombein and Willink
– Clypeus of female all or mostly yellow, penultimate tergum often all black, S-II to V all black, of male all black or with minute pale spots on S-II or S-II-III . . . . . *strenuus* (Mickel)
8. Tergal bands deep orange-yellow, female hindleg usually all black, male hindleg sometimes so 9
– Tergal bands not deep orange-yellow, often paler laterally, hindleg not all black 10
9. T-VI in female with a shiny median longitudinal carina, female scutellum with relatively small and close punctures, scutellum in both sexes often all yellow (in Central America), UA protruding well beyond LA in dorsal view of thorax, T-I sometimes all black . . . . . *agilis* (F. Smith)
– T-VI in female without a median longitudinal carina, female scutellum with some relatively large and well spaced punctures, scutellum with lateral spots or sometimes all black, UA hardly protruding beyond LA in dorsal view

of thorax, T-I with yellow band or two yellow spots but not all black . . . . . *mexicanus* (Handlirsch)

10. Submarginal cell II with petiole nearly equal in length to MOD (Fig. 2), T-VI in female with a weak median longitudinal carina (Fig. 12), semierect lateral hairs on last abdominal segment white, clypeal apex of female with an apicolateral tuft (Fig. 21) . . . . . *quinquespinosus* (Say)
– Submarginal cell II not petiolate (as in Fig. 1), T-VI in female without any trace of a median longitudinal carina, other characters various 11
11. Outstanding hairs of last abdominal segment fulvous or brownish, if black (in female), clypeus yellow and apex without a lateral tuft, tergal bands of female light yellow; male nearly always extensively yellow . . . . . *neglectus* (Cresson)
– Outstanding hairs of last abdominal segment white, clypeus of female with a large central maculation and a small apicolateral tuft (Fig. 20), tergal bands of female whitish, originally described male not conspecific (see discussion) . . . . . *moneduloides* (F. Smith)

Bembecinus agilis (F. Smith)
(Fig. 5)

Larra cingulata F. Smith 1856:340. Holotype female, Brazil (LONDON). Preocc. Fabricius 1798.

**Larra agilis* F. Smith 1873:402. Holotype female, Ega, Brazil (LONDON).

Bembidula ornaticauda Cameron 1912:432. Holotype female, British Guiana (LONDON).

I have been able to study more than 100 specimens of this species. Some of these were collected in South American countries. However, *agilis* occurs in Central America, and five males and 67 females in the Bohart Museum are from Panama (Barro Colorado Island), El Salvador (Quezaltepeque), Guatemala (El Asintal), and Vera Cruz, Mexico (Coscomatapec). The Guatemalan specimens were a long series collected by K. and S. Bloem. Most of the Central American material, especially females, have the scutellum and metanotum all yellow. In 90 percent of the Central American specimens T-I is all black. All material I have seen has the mandible black basad and the median forewing cell with an apical spot. Other features are the median longitudinal carina of the female pygidium, a narrowly rounded and projecting UA (Fig. 5), and a scutellum without megapunctures. Three females (Trinidad, Panama, Guatemala) were pinned with prey, a large cicadellid.

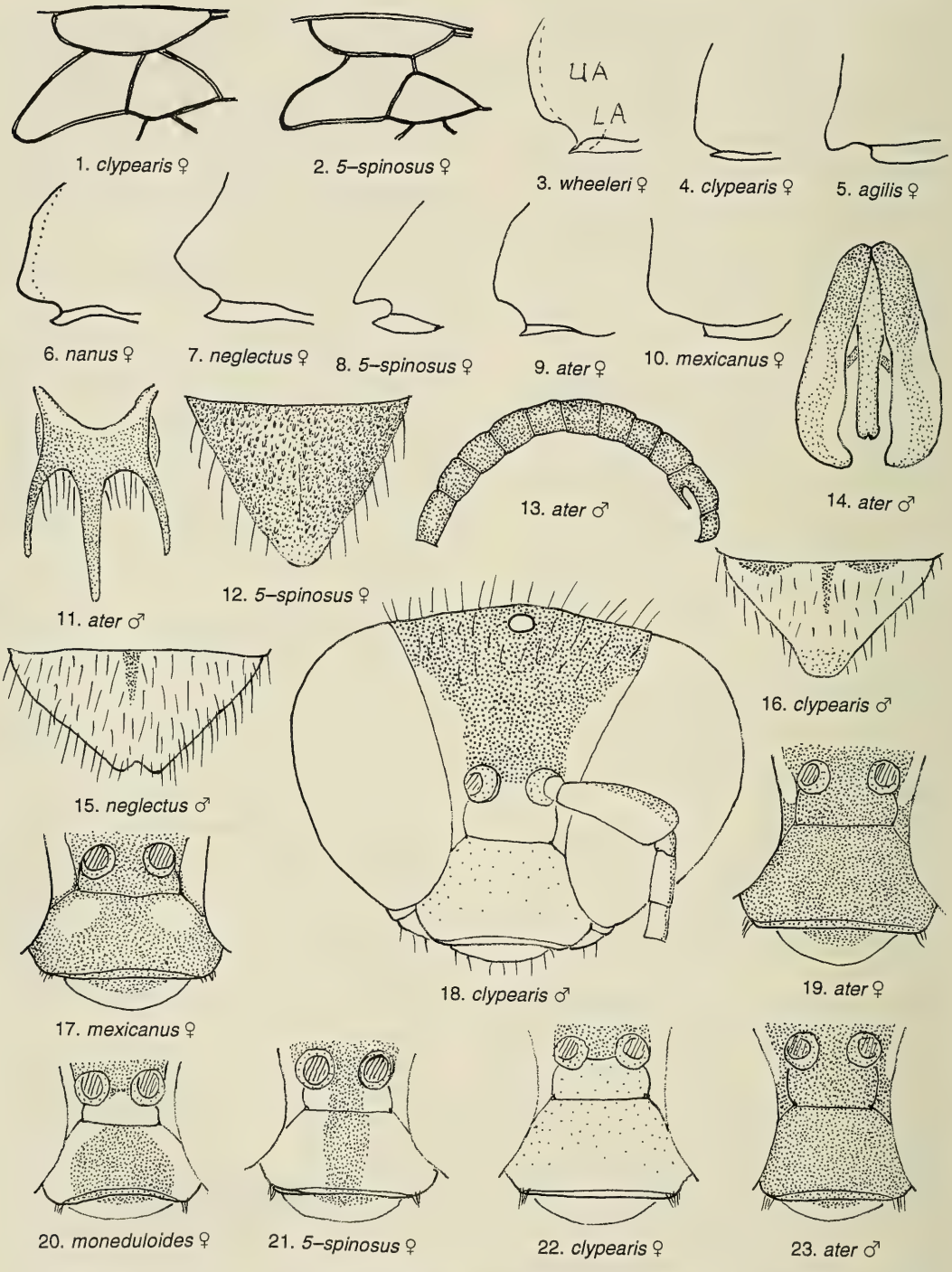
A somewhat similar species is *mexicanus* which is treated below.

Bembecinus ater R. Bohart, new species
(Figs. 9, 11, 13, 14, 19, 23)

Female holotype.—length 9.5 mm. Black, light yellow are: antenna in front, crescentic spot on labrum (Fig. 19), lateral strips on lower frons, band across pronotum including lateral lobes, tegula and post-tegula partly, lateral spots on scutum and scutellum, metanotum, propodeal flange apically, femora distally, tibiae partly, basitarsi posteriorly, tarsals II to IV mostly, T-I to V with posterior bands, those on II-VI enlarged laterally and medially, lateral spots on S-II-III; wings clear; tarsal V reddish brown. Pubescence mostly silvery, including lateral tergal hair; clypeus with apicolateral tuft, wings densely microsetose; posterior hair fringe of terga faintly fulvous. Punctation fine, inconspicuous. Clypeal proportions as in Fig. 19; propodeal flange (UA, lateral view) almost evenly but slightly obtusely rounded (Fig. 9); second submarginal cell not petiolate but narrowed above (as in Fig. 1).

Male: about as in female, clypeus black but sometimes with tiny yellow spots, LID narrower (Fig. 23), T-VI sometimes with a median spot, S-I to III with lateral spots, S-VII distinctly notched apically, clasper of genitalia nearly all pale yellow toward apex (Fig. 14), flagellum brown in front (Fig. 13).

Female holotype (DAVIS), near Douglas, Cochise Co., Arizona, VII-27-79 (R. M. Bohart). Paratypes (Arizona), male, 10 females, same data as holotype but VIII-9 to IX-1; male, female, Skeleton Canyon (R.



Figs. 1–23. 1–2, Forewing marginal cell and first and second submarginals. 3–10, Lateral view of propodeal flange. 11, S-VIII. 12, T-VI. 13, Flagellum, from view. 14, Genitalia, dorsal view. 15–16, T-VII. 17, 19–23, Lower frons. 18, Head, front view.

Bohart); male, Molino Basin, Santa Catalina Mts. (R. Bohart); male, Canelo (G. Butler); male, Tucson Mts. (G. Butler); male, Peppersauce Canyon, Santa Catalina Mts. (R. Beal); female, Tombstone (R. Bohart); female, Madera Canyon (R. Kimsey); female, 11 mi. s. Pearce (R. Bohart); female, Portal (J. Wilcox); female, 4 mi. s. Apache (R. Bohart). Paratypes were all collected in August and September. They will be distributed to the following museums: DAVIS, SAN FRANCISCO, LAWRENCE, LOGAN, AUSTIN (1), AUSTIN (2), NEW YORK, WASHINGTON.

The all or nearly all black clypeus (Figs. 19, 23) and basally black mandible in both sexes, slightly obtusely rounded propodeal flange (Fig. 9), and whitish lateral hairs of terminal abdominal segments are diagnostic taken in combination. Tergal markings vary from yellow to whitish yellow. Male characters of note are the brown frontal view of the flagellum (Fig. 13) and the apically notched T-VI. Occasional females of *wheeleri* may have the clypeus essentially black, but these have the mandible yellow basad. Some females of *ater* have the propodeal flange a little more obtusely rounded than others.

Bembecinus bishoppi Krombein and Willink

**Bembecinus bishoppi* Krombein and Willink 1951:710. Holotype male, Midland, Texas (WASHINGTON).

Structurally, this species is quite similar to *wheeleri.* The principal difference is the red markings, especially on the hindfemur in *bishoppi.* Shape and markings of the clypeus are much the same. The propodeal flange (UA) of *wheeleri* is more evenly rounded, and this character is crucial to distinguish the few males of *bishoppi* with little red on the hindfemur.

In addition to the holotype and some of the paratypes of Krombein and Willink from Texas, I have seen 2 males and 7 females as follows: male, Mesquite Canyon near Mitre Peak, Jeff Davis Co., Texas (J. E. Gillaspy); 2 females, Big Bend National Park, Brewster Co., Texas (R. M. Bohart, A. C. Minkley); 11 males, 4 females, Devil's River, Val Verde Co., Texas (A. W. Hook); 4 females, Portal, Cochise Co., Arizona (R. M. and G. E. Bohart); male, 2 females, Apache, Cochise Co., Arizona (R. M. Bohart).

Bembecinus clypearis R. Bohart, new species

(Figs. 1, 4, 16, 18, 22)

Female holotype.—length 9 mm. Black, light yellow are: basal two-thirds of clypeus, supraclypeal spot, lower frons laterally, band across pronotum extending to lateral lobes, lateral scutellar spot, crescentic spot across metanotum; whitish are: antenna in front, labrum, mandible basally, apical one-third of clypeus, outer spots on tegula and post-tegula, propodeal flange apically, femora distally, foretibia outwardly, mid- and hindtibia except toward apex, tarsi except posterior black edging, hindtarsal V mostly black; posterior bands on T-I to T-V, those on T-II to T-V enlarged laterally and medially, lateral spots on S-II to S-IV. Pubescence silvery and appressed on head, clypeus with small apicolateral tuft, mesonotal pubescence a little fulvous, that of terga pale including dense posterior fringe of T-I to T-V, pygidium covered with short black setae, lateral hairs white, wing cells extensively microsetose. Punctation generally fine, inconspicuous. Clypeal proportions as in Fig. 22; propodeal flange (UA, lateral view) obtusely rounded (Fig. 4); second submarginal cell narrowed above but not petiolate (Fig. 1).

Male.—length 9–11 mm. Extensively yellow with black edging, black especially on antenna behind, frons extensively, scutum mostly, terga and sterna basally, S-VIII entirely; thoracic pale markings mostly light yellow; tibiae, tarsi, and abdomen with whitish markings; genitalia mottled brown and white. T-VII rounded or nearly truncate

at apex, not notched (Fig. 16); S-VII with raised median carina.

Holotype female (DAVIS), 4 mi. e. Nogales, Santa Cruz Co., Arizona, VIII-19-76 (R. M. Bohart). Paratypes (Arizona): 15 males, 3 females, same data as holotype but some 5 mi. e.; male, 2 females near Apache (M. Cazier, V. Roth); male, female, near Douglas (J. Rosen et al.); female, Portal, 5 mi. e. (G. Bohart); male, Santa Rita Mts. (R. Kimsey). Other paratypes: (New Mexico) female, Rodeo (R. Bohart); female, Organ Mts., (E. Grissell, R. Denno); (Sonora, Mexico) 2 males, Alamos (R. G. and A. Bohart), male, 3 females, 13 k. w. Alamos (B. Villegas); 3 males, 2 females, near Navajo (R., G., and A. Bohart). Paratypes were all collected during August and September. They will be distributed to the following museums: DAVIS, SAN FRANCISCO, LOGAN, AUSTIN (1), AUSTIN (2), NEW YORK, WASHINGTON.

The combination of an obtusely rounded propodeal flange (Fig. 4) and pale bicolored clypeus (Figs. 18, 22) differentiates the species. Apparently, *clypearis* is like *neglectus,* in which the male is always or nearly always of the flavid form. Species in which some of the males are flavid are *mexicanus* and *quinquespinosus.*

Bembecinus floridanus Krombein and Willink, **new status**

**Bembecinus nanus floridanus* Krombein and Willink 1951:706. Holotype male, Miami, Florida (WASHINGTON).

Larra moneduloides F. Smith 1856:346. Male only, St. Johns Bluff, Florida. Female designated as lectotype herein.

As in *nanus* and *strenuus,* outstanding lateral hairs of the last abdominal segment are black. Also, some of those on the next to last segment are black. *B. nanus* material which I have seen (37 males, 42 females) from Florida, North Carolina, Mississippi, Illinois, Oklahoma, and Texas have tergal markings yellow (often deep yellow), and females have the clypeus extensively yellow. Most specimens of *nanus* have submarginal cell II with a short petiole. Krombein and Willink (1951) had not seen any females of *floridanus,* and considered the whitish markings of males of subspecific value only. I have studied 8 males and 7 females of *floridanus* from Ocala, Marion Co., Florida and Archbold Biological Station, Highlands Co., Florida. All of the females have the clypeus entirely black. Both sexes have the tergal markings whitish, those on T-I sometimes whitish yellow. Also, submarginal cell II is narrow in front, but not petiolate. For these reasons I am treating *floridanus* as a separate species. A comparison with *strenuus* is given under that species.

Bembecinus mexicanus (Handlirsch) (Figs. 10, 17)

Stizus mexicanus Handlirsch 1892:66. Syntypes, male, female, Orizaba and Vera Cruz, Mexico (VIENNA).

Stizus guttulatus Handlirsch 1892:67. Holotype male, Mexico (VIENNA).

Stizus chichimeca Saussure 1892:466. Footnote 1. Cordova, Mexico, male (GENEVA?).

This is the largest species of *Bembecinus* north of South America. Females are usually 13–15 mm long. However, as in other provisioning sphecids, food can be short, and size will consequently vary. I have seen one female from Vera Cruz, Mexico, which is only 10 mm long.

Willink (1949) has written extensively on this species, recording it from Vera Cruz, Yucatán, and British Honduras. I have seen Mexican specimens from Sonora, Sinaloa, Jalisco, San Luis Potosi, Morelos, Campeche, Puebla, Chiapas, Quintana Roo, Vera Cruz, Tamaulipas, and Chihuahua.

Willink 1949:106 suggested its relationship to *agilis,* separating it by the broader female clypeus of *mexicanus* (Fig. 17), and differences in the propodeal flanges (Figs. 5, 10). Willink pointed out that in dorsal view UA of *mexicanus* was exceeded by

LA instead of the reverse as in *agilis*. Also, female *agilis* has a longitudinal carina on T-VI and the scutellum has no megapunctures.

Bembecinus moneduloides (F. Smith)
(Fig. 20)

**Larra moneduloides* F. Smith 1856:346. Male, female syntypes, St. Johns Bluff, Florida (LONDON); female here designated as lectotype.

Identity of this species has been a puzzle, and the lectotype designation is designed to clarify the situation. Krombein and Willink (1951:705) left the question open. They quoted a letter from Mr. Benson of the British Museum as saying that "the type of *Larra moneduloides* Smith is a female, but is quite unlike the specimens you sent named *nanus*". Also, Mr. Benson indicated that the male syntype of *moneduloides* "is *B. nanus floridanus*". I have not seen the male but have included it under the synonymy of *floridanus*.

The female lectotype is quite similar to several specimens in the Bohart Museum collection from Asia and Africa. Therefore, I have concluded that the type locality given by Smith was in error. The actual identity of this exotic species awaits further study.

Additional notes on *moneduloides* were given by Willink (1957). He concluded that it was distinct from any other known species from North America. I agree because: second submarginal cell not petiolate, lateral tergal hair pale, T-VI with no median carina, scutellum with no coarse punctures, female clypeus maculate and apically tufted (Fig. 20), and propodeal flange moderately notched.

Bembecinus nanus (Handlirsch)
(Fig. 6)

**Stizus nanus* (Handlirsch) 1892:61. Lectotype female (here designated), Georgia (VIENNA).

This species was described in some detail by Krombein and Willink 1951:702, 706. It is one of 3 species, as considered here, with black outstanding hair laterally on T-V to VI (female) and T-VI to VII (male). The other 2 are *floridanus* and *strenuus*, which were treated as subspecies by Krombein and Willink. These authors gave *nanus* distribution as New Jersey to northern Florida, Gulf States to Texas, Iowa and eastern Nebraska. In addition I have collected it in Oklahoma, and a long series from Illinois was collected by M. E. Irwin (DAVIS). Another long series (14 males, 25 females) collected by A. W. Hook in Bastrop Co., Texas was studied (AUSTIN, 1). All of these had the tergal bands (T-I-V) yellow, the hindtibia practically all yellow and the clypeus yellow as well as apicolaterally bearded. Of 23 males and 17 females of *nanus* in the Bohart Museum collection, 21 males and all females have submarginal cell II with a short petiole. I have not seen this feature in any of our *floridanus*, but sometimes in female *strenuus*.

Bembecinus neglectus (Cresson)
(Figs. 7, 15)

**Monedula neglecta* Cresson 1872:222. Holotype female, Comal Co., Texas (PHILADELPHIA).

**Stizus xanthochrous* Handlirsch 1892:69. Syntype males, Dallas, Texas (VIENNA). Flavid males.

Krombein and Willink (1951) recorded this species from Louisiana, Mississippi, Texas, and Nebraska. Among the approximately 100 specimens I have seen, Oklahoma (Willis) and Colorado (Rogan) can be added. A long series (31 males and 43 females) mostly collected by A. W. Hook in Blanco Co., Texas were studied. As usual in this species, males were nearly all yellow and had 4 pronounced yellow stripes on the scutum. However, 2 of the males were only a little yellower than the females. Also, they were smaller than usual (about 9 mm long) instead of the 10–13 mm prevailing size.

General characters of the species are: clypeus all yellow and without an apicolateral patch of setae, T-VII (males) and T-VI (females) with dark or black outstanding lateral setae, other lateral tergal setae pale, submarginal cell II not petiolate, lateral propodeal flange with UA forming a broad notch with LA, male F-XI with a ventral tubercle, and female sterna with pale bands or lateral spots on S-II-IV.

In comparison with other species, the flavid males I have seen of *clypearis* and *mexicanus* are less extreme than those of *neglectus,* and the scutal stripes, when present, are narrower. In *quinquespinosus* there is considerable variation, but some males are as extensively yellow as in *neglectus.* However, aside from markings, the broader notch of the propodeal flange in *neglectus,* along with the non-petiolate submarginal cell II, larger size, no lateral clypeal setal patch, and the ventral tubercle on male F-XI provide easy separation. In *strenuus* the practically all-black sterna are differentiating, along with the black lateral setae of T-VI in males and T-V in females.

Bembecinus quinquespinosus (Say)
(Figs. 2, 8, 12, 21)

Nysson quinquespinosus Say 1823:78. Syntypes, Arkansas (LOST).

Stizus godmani Cameron 1890:102; Pl. 5, Fig. 8. Lectotype male (desig. Willink 1957(1956):703), Atoyac, Vera Cruz, Mexico (LONDON).

Stizus lineatus Cameron 1890:103. Holotype male, Atoyac, Vera Cruz, Mexico (LONDON, missing?), flavid variety.

Stizus flavus Cameron 1890:103. Syntype males, Jalisco, Mexico; Vera Paz, Guatemala (LONDON), flavid variety.

**Stizus flavus subalpinus* Cockerell 1898: 142. Holotype male, Santa Fé, New Mexico (WASHINGTON), flavid variety.

Nysson cressoni Cameron 1904:95. Holotype female, "N. Mexico" (northern Mexico) (LONDON).

This species is by far the most abundant of those in Central and North America. As an example, the Bohart Museum has 143 males and 253 females. This is more than all other species together. The primary specific characters are the strongly notched propodeal flange (Fig. 8), and the petiolate as well as broad submarginal cell II (Fig. 21). The only other species which commonly has a petiolate submarginal is *nanus.* Here, the petiole is quite short, however, and the black outstanding hair of the last 2 terga in *nanus* makes differentiation easy.

Placement of the name *quinquespinosus* Say (1823) was made by Bohart in Bohart and Menke 1976:532. The name had not previously been ascribed to *Bembecinus,* and did not fit under *Nysson,* where Say put it. I realized that the five spines implicit in the name were derived from the sharp point on each propodeal flange plus the three spines of male sternum VIII.

I have seen hundreds of specimens of *quinquespinosus* in various collections, but the Bohart Museum material will serve for analysis of some of the observed variables. In the 43 males, 12, or about 27 percent, are the flavid variety. Several of these are intermediate in coloration. In the 253 females, 226, or about 91 percent, have a median black clypeal spot. The other nine percent have the clypeus black except for a lateral yellow spot or dot. These latter are mostly from Chihuahua, Mexico, but many other Mexican states are represented, and one female is from El Salvador. The nearly or all black clypeus occurs in *ater* and *floridanus* females but these are easily separated as shown in the key. Practically all females and all dark males have tergal markings whitish laterally, grading to yellow medially. All specimens have an apicolateral clypeal hair tuft, but this is not well developed in flavid males.

Krombein and Willink 1951:704 treated the South American representative of *quinquespinosus* (= *godmani*) as a subspecies *bolivari* (Handlirsch). The presence of a faint spot at the end of the forewing medial cell and the more brownish pubescence of the head and scutum have been used as in-

dicators of *bolivari.* Unfortunately for the value of these simple differences, they are variable in many specimens from Panama and Costa Rica. This is a weak division of a species ranging from the United States to Argentina.

I collected a female at Lake Texoma near Willis, Oklahoma, in June, 1965. Extracted from her provisioned nest in sandy ground were nine nymphal and adult leafhoppers in the genera *Carneocephala* and *Graphocephala* (det. N. Frazier).

Bembecinus strenuus (Mickel), **new status**

Stizus strenuus Mickel 1917:331. Holotype male, Bridgeport, Nebraska (LINCOLN).
Bembecinus nanus strenuus Krombein and Willink 1951:707.

I have studied 25 males and 33 females of this species. Its relationship to *nanus* is indicated by the black outstanding hair laterally on the last two abdominal segments. However, in all my specimens the sterna are black, except a few males with tiny whitish spots laterally on S-II-III. Males have T-VI-VII black, females have T-V usually with a medium pale spot. Both sexes have the inside of the hindtibia and hindbasitarsus extensively black. Markings of the terga are whitish or whitish yellow. These are differences from *nanus.* The clypeus and supraclypeal spot in both sexes are uniformly yellow. Also, there is a marked hair tuft apicolaterally on the male and female clypeus. Occasional females have submarginal cell II with a short but distinct petiole.

Krombein and Willink (1951:707) recorded *strenuus* from Nebraska, South Dakota, Wyoming, and several counties in Texas. My material is from Marshall Co., Oklahoma (Lake Texoma); Alcorn Co., Mississippi (Alcorn); and Texas: Lee Co., Wade Co., Guadalupe Co., Willacy Co., Dimmit Co., Bastrop Co., I have also seen specimens from near Medicine Lodge, Barber Co., Kansas; Rogan, Weld Co., Colorado; and Tucumcari, Quay Co., New Mexico.

I collected nesting females in sandy areas along Lake Texoma. The prey were adults and nymphs of several species of leafhoppers in the genera *Carneocephala* and *Graphocephala* (det. N. Frazier).

Bembecinus wheeleri Krombein and Willink
(Fig. 3)

**Bembecinus wheeleri* Krombein and Willink 1951:709. Holotype male, Fort Grant, Pinaleño Mts., Arizona (CAMBRIDGE).

The almost perfectly rounded propodeal flange (UA) is characteristic of this species. The female clypeus has two pale spots, but I have one specimen with the clypeus all black as in *ater.* However, the mandible is basally yellow, whereas in *ater* it is black. The propodeal flange is different, too (compare Figs. 3, 9). *B. wheeleri* may be confused with *clypeatus,* but females of that have the clypeus two shades of yellow, and UA is slightly irregular (compare Figs. 3, 4). Male *clypearis* is flavid, and this condition is not known in *wheeleri.*

The type series was all from Arizona: Fort Grant, Tucson and south of Tucson, Peña Blanca, Peppersauce Canyon. The 24 males and 9 females in the Bohart Museum are mostly from Arizona also: Sabino Canyon, Tucson, Dragoon Mts., Bowie, Nogales. However, the distribution includes much more of the Southwest. Some of our specimens are from west Texas: Presidio; New Mexico: Rodeo, 8 mi. w. Animas; California: Scissors Crossing (San Diego Co.). Mexico is also represented: Sonora: near Alamos, near Magdalena; Baja California: Puerto Escondido; Baja California Sur: Cataviña.

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MEUNIERIELLA AVICENNIAE (COOK) (DIPTERA: CECIDOMYIIDAE) THE LEAF GALL MAKER OF BLACK MANGROVE IN THE AMERICAN TROPICS

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Abstract.—The male, female, pupa, and larva of *Meunieriella avicenniae* Cook, **n. comb.,** are described for the first time. The species was previously known only as "*Cecidomyia*" *avicenniae* from its galls on New World mangroves. This species is remarkable because it shows the most primitive state of the male postabdomen in the genus. It is now possible to confirm that *Meunieriella* belongs to the tribe Alycaulini because it shares with all other members of that tribe the smooth, asetulose area on the dorsum of the female ninth abdominal segment, a character unique to the tribe.

Key Words: gall midges, Avicennia, West Indies

Leaf galls made by the cecidomyiid *Cecidomyia avicenniae* Cook on black mangrove, *Avicennia* spp., were first reported by Cook (1909) from Cuba. Galls are about 5 mm in diameter, rounded and smooth on the top of the leaf and warty on the bottom of the leaf. Galls are first green, then turn brown after the larvae are fully fed. The larva pupates in the gall. A craterlike exit hole eventually develops, the pupa pushes halfway through the exit, and the adult breaks through the pupal head.

Cook (1909) recorded his galls from *Avicennia nitida* Jacq., which is listed in Tomlinson (1986) as a synonym of *Avicennia germinans* (L.) Stearn. Tomlinson (1986) records the occurrence of only two species of *Avicennia* on the Atlantic side of the Americas. These are *A. germinans,* ranging from southern Florida and the Bahamas throughout the Caribbean to Mexico and Central America, and *A. schaueriana* Stapf and Leechman ex Moldenke 1939 from the Lesser Antilles and along the coast of South America from Guyana to Uruguay. Subsequent collections of galls similar to those found by Cook were recorded from Bahia, Brazil on *Avicennia tomentosa* (Tavares 1918) and from French Guiana on *Avicennia officinalis* (Houard 1924). Tomlinson (1986) lists *A. tomentosa* as a synonym of *A. germinans* but cautions that past determinations as *tomentosa* could have been in error. *Avicennia officinalis* is an Old World species, so the actual host in French Guiana was either *A. germinans* or *A. schaueriana.* More recently, similar galls have been reported from Florida, USA, and Belize from *A. germinans* (Gagné 1994), and are newly reported here from Guadeloupe and Saint Martin, also on *A. germinans.*

Cecidomyia avicenniae Cook was based on a three-line description of the gall. According to present rules of nomenclature, such a name published before 1931 is valid because it was based on the work of an an-

imal. Cook placed the species in *Cecidomyia* only because that genus was at the time a catchall category for species that could otherwise not be placed to a definite genus (Gagné 1989). Only now, with the recent collection of larvae, pupae, and adults by one of us (JE) in Guadeloupe and Saint Martin, can this species be described and assigned to its correct genus. We are not fully certain that the species from Guadeloupe is the same as that from Cuba, but we presume it is because pupae and larvae taken from similar galls from Belize, farther from Guadeloupe than is Cuba, are similar to those from Guadeloupe.

Meunieriella avicenniae is of more than passing interest for several reasons. Unlike all other Neotropical *Meunieriella* species, which are inquilines in galls made by other gall midges, this species is a gall maker. It shows the most primitive state of the male postabdomen in the genus, and we point out for the first time a peculiarity in this genus, that the male sixth through eighth abdominal segments are retractable. In addition, we now realize that the dorsal, smooth, asetulose area on the ninth segment of the female abdomen is a shared derived characteristic of all species of the tribe Alycaulini, confirming that *Meunieriella* belongs to this tribe.

Methods

Larvae and pupae were obtained by dissecting fresh field-collected galls. Adults were reared from galls kept in transparent, plastic containers. Specimens were stored in 70% ethanol. All stages were mounted for microscopic study in Canada balsam, using the method outlined in Gagné (1989, 1994). In the descriptions that follow, anatomical terminology of the adult stage follows McAlpine et al. (1981) and that of the larval stage follows Gagné (1989). Specimens are deposited in the National Museum of Natural History, Washington, D.C., in the Muséum National d'Histoire Naturelle, Paris, and in the Station de Zoologie et Lutte Biologique, INRA, Guadeloupe.

Meunieriella avicenniae (Cook), **new combination**

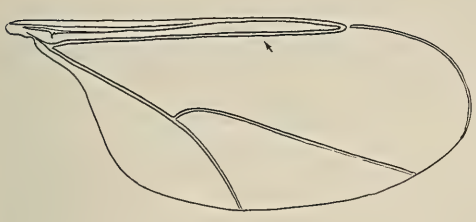
Cecidomyia avicenniae Cook 1909: 145.

Adult.—Head: antenna (Figs. 2–3) with 14–16 flagellomeres, all longer than wide and slightly more than half diameter of spherical pedicel; first and second flagellomeres connate. Palpus four segmented. Labella hemispherical.

Thorax: Wing (Fig. 1), 1.4–1.6 mm long; R_5 0.72–0.75 length of wing. Scutum with four longitudinal rows of setae and scales, the scales more extensive than the setae, almost contiguous between rows; scutellum with a group of setae and a few scales on each side; anepisternum bare; mesepimeron covered with setae and a few scales. Tarsal claws with large tooth; empodia as long as claws.

Male abdomen (Figs. 6–9): Sixth through eighth segments retractable into anterior part of abdomen; first through fifth tergites rectangular, with anterior pair of trichoid sensilla, posterior margin with single to double row of setae, otherwise covered with scales; sixth through eighth tergites rectangular, narrower than fifth tergite, weakly sclerotized, each with anterior pair of trichoid sensilla and apical row of setae; second to fifth sternites rectangular, with anterior pair of trichoid sensilla, setae across midlength and posterior margin, and covered elsewhere with scales; sixth through eighth sternites rectangular, weakly sclerotized, each with scattered setae on posterior half; gonocoxite cylindrical, not greatly attenuate; gonostylus tapered beyond midlength, about two-thirds length of gonostylus; cerci rounded apically; hypoproct slightly shorter than cerci, rounded apically; gonostylus with only two lobes apically, each with an apical seta; aedeagus more than half length of gonocoxite.

Female abdomen (Figs. 4–5, 11–12): First through seventh tergites rectangular as for male first through fifth, seventh tergite much narrower than sixth; eighth tergite narrower than seventh, bare except for an-



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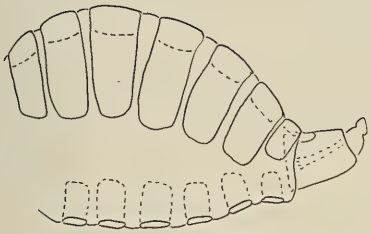

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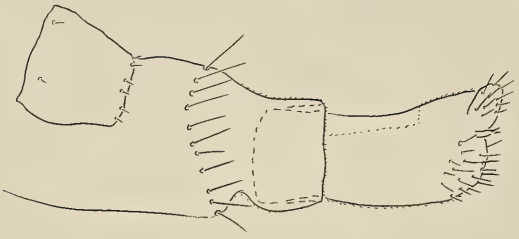

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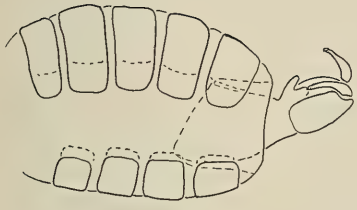

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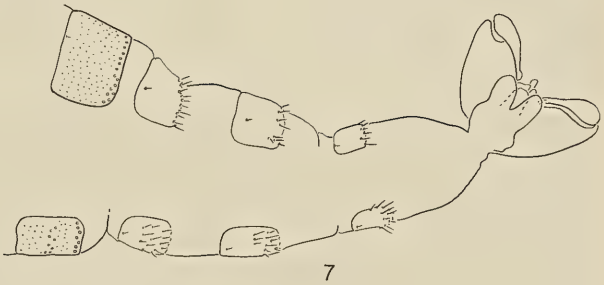

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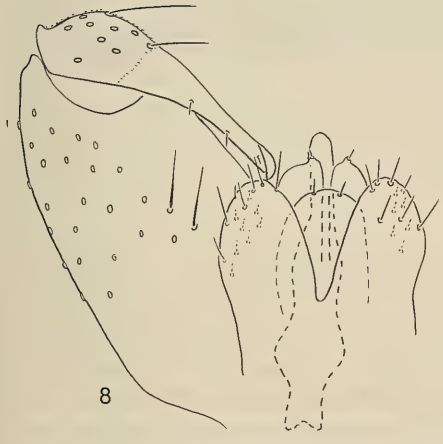

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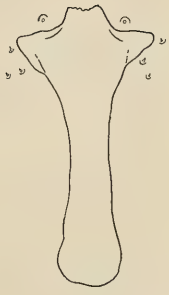

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Figs. 1–10. *Meunieriella avicenniae.* 1, Wing (arrow points to R_5 wing vein). 2, Scape, pedicel, and first four flagellomeres of antenna (lateral). 3, Detail of fourth flagellomere (lateral). 4, Female abdomen (dorsolateral). 5, Female postabdomen, eighth segment to end (dorsolateral). 6, Male abdomen, showing sixth through eighth segments retracted into anterior part of abdomen (lateral). 7, Male abdomen, fifth segment to end, (lateral except genitalia dorsal). 8, Male genitalia (dorsal). 9, Same (lateral, the near gonopod removed). 10, Larval spatula and associated papillae.

terior pair of trichoid sensilla and single row of short setae along posterior margin; second through seventh sternites rectangular, as for male second through fifth; eighth sternum unsclerotized, without visible sclerite; apex of eighth segment ringed with single row of long setae; ninth segment dorsally with smooth, asetulose area, partially bisected by a line of setulae, elsewhere covered with minute setulae; fused cerci bulbous, spheroidal, covered with long setae; hypoproct short, with apical setae; venter of ovipositor apex covered with long setae.

Pupa (Figs. 13–14).—Antennal sheath bases not greatly prolonged, carinate along apicoventral edge. Face without papillae, with two pairs of convex protuberances, one at anterolateral corners, the other near middle of sclerite. Cervical setae not greatly surpassing antennal bases anteriorly. Prothoracic spiracle no longer than width of adjacent antennal sheath.

Larva (Figs. 10, 15–16).—Spatula with denticulate anterior projection with conspicuous lateral development subanteriorly. Papillae basic to tribe Alycaulini except that lateral papillae (Fig. 10) reduced to three on each side of the spatula, each of these papillae with short seta, and terminal segment with only one pair of papillae that are difficult to distinguish among the spicules covering this segment.

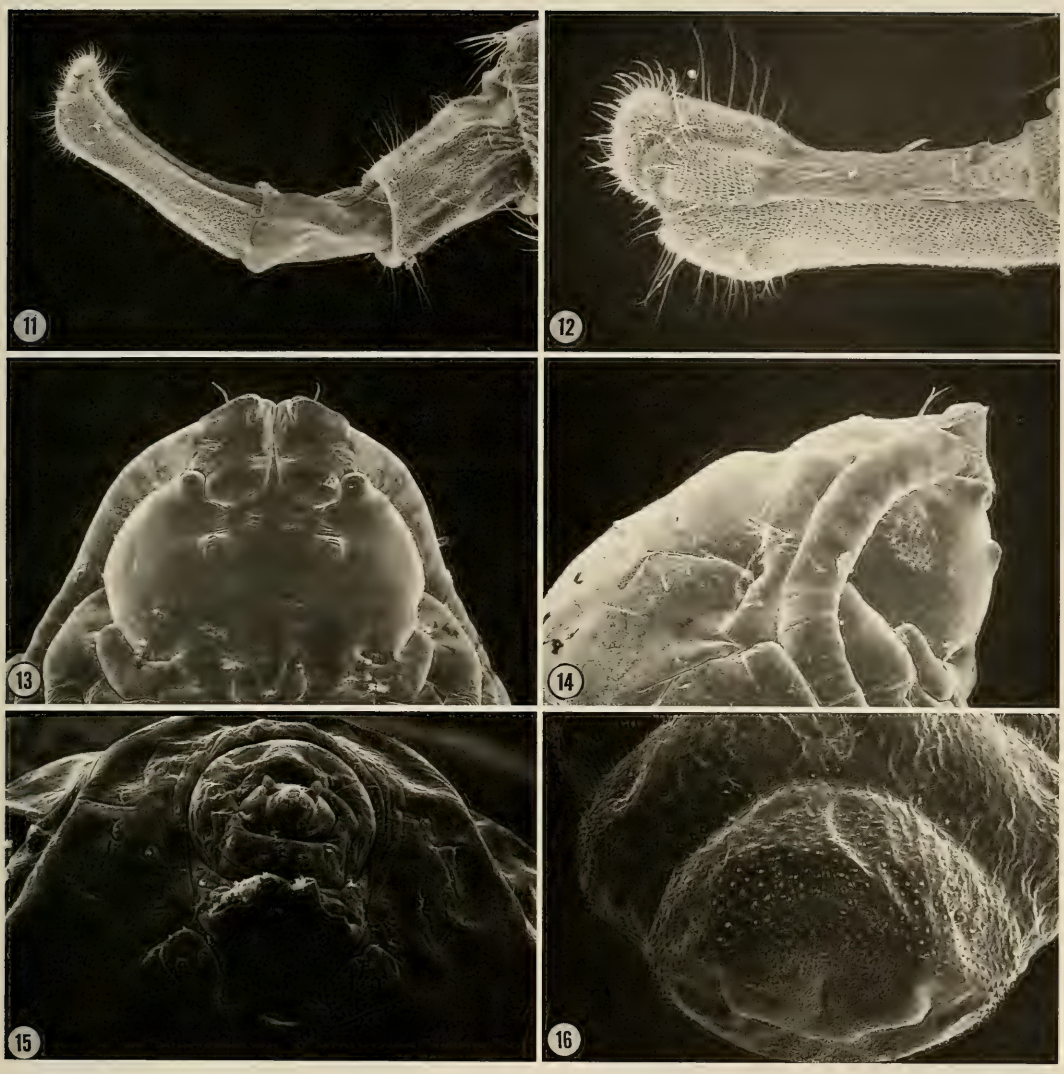
Types.—Leaf galls on leaves of *A. germinans* (as *nitida*) from unspecified locality in Cuba. Not seen, presumably lost.

Specimens examined (all from *Avicennia germinans*).—BELIZE: Twin Keys, second instars, 7-VIII-1991, and pupa, 20-VIII-1991, C. Feller. GUADELOUPE, all from Plage Sainte Claire, Goyave, collected by J. Etienne: 30-I-1992, adults; 19-XII-1992, adults; 17-I-1995, adults; 6-II-1995 adults; 4-V-1995, pupae and third instars; and no date (GR-1592), galls, pupae and third instars. SAINT MARTIN: Anse Marcel, 19-V-1995, J. Etienne, galls, adults.

Comments.—*Meunieriella avicenniae* is one of 21 species of *Meunieriella,* 20 of them Neotropical, one Nearctic. Together with the Nearctic species, *Meunieriella aquilonia* Gagné, responsible for simple leaf blisters on honey locust (Gagné and Valley 1984), *M. avicenniae* is a gall maker, being the only species repeatedly found in association with mangrove galls in Guadeloupe. The remaining 19 Neotropical species of *Meunieriella* are inquilines or guests in galls of other cecidomyiids (Möhn 1975, Wünsch 1979, Gagné 1994).

Meunieriella avicenniae can be differentiated from all other known species of *Meunieriella* by adult, pupal, and larval characters. The R_5 wing vein of *M. avicenniae* is about 7/10 the total length of the wing, while it is only about 5/10 as long in all other known species. The male sixth through eighth abdominal tergites, although smaller and less sclerotized than the fifth tergite, are rectangular and have a posterior row of setae. In all other known species, these tergites are reduced to a narrow transverse band and lack all posterior setae. The genitalia of *M. avicenniae* (Figs. 8–9) are much less modified than in the other species, in which the gonocoxites and gonostyli are extremely attenuate and much longer in relation to the hypoproct and aedeagus than in *M. avicenniae.* The pupa of *M. avicenniae* has convex protuberances on the face (Figs. 13–14), unlike all other known *Meunieriella* species, which have none. The face lacks papillae; all other known *Meunieriella* species have two pairs of papillae anterior to the labellum and three papillae anterior to the base of each palpus. The larval spatula of *M. avicenniae* has a single, denticulate anterior projection unlike the two evenly triangular projections found in other species; the terminal larval segment is unique also for its single pair of reduced papillae, unlike the four pairs of papillae with long setae present in other species.

Gagné (1994) placed *Meunieriella* in the tribe Camptoneuromyiini instead of the tribe Alycaulini, to which it now obviously belongs. The male postabdomens of then known *Meunieriella* spp. were too reduced and modified to show the character that dis-



Figs. 11–16. *Meunieriella avicenniae*. 11, Ovipositor, eighth segment to end (lateral). 12, Ovipositor, ninth segment to end to show dorsal, smooth, asetulose area (dorsolateral). 13, Pupa, anterior segments (ventral). 14, Same (lateral). 15, Larva, anterior segments, showing head and spatula (ventral). 16, Larva, posterior segments (posterodorsal).

tinguishes male Alycaulini from all other tribes of Lasiopteridi. This character is the reduction of the sixth to eighth tergites of Alycaulini progressing from the anterior to the posterior margins, the effect being that the posterior setae are usually visible even on greatly reduced male tergites in Alycaulini. In the other tribes of Lasiopteridi, reduction progresses from the posterior margin of the tergites, so posterior setae are the first casualty of reduction. In previously known *Meunieriella* species the posterior tergites were so reduced that this progression could not be determined, so weight was given to the inquilinous habit of most *Meunieriella* species in placing the genus with the Camptoneuromyiini. Not only are the male sixth through eighth tergites of male *Meunieriella avicenniae* fully setose posteriorly, but we now appreciate, after a

recent canvass by one of us (RJG) that the dorsal, smooth, asetulose area on the ninth segment of the female (Fig. 12) is a unique shared derived character of all Alycaulini. These characters of the male and female postabdomens serve to place *Meunieriella* with certainty in the Alycaulini. That larvae have only 3–4 papillae instead of 6 on each side of the spatula is further confirmation that this genus belongs here, even though that character is not unique to the tribe. The complete retractability of the male sixth through eighth abdominal segments within the anterior part of the abdomen is unique to this genus.

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TWO NEW GENERA AND TWO NEW SPECIES OF NEW WORLD STILT BUGS (HETEROPTERA: BERYTIDAE)

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Abstract.—The new genera and species ***Diabolonotus pilosus*** from Mexico (Chiapas), and ***Oedalocanthus ornatus*** from Belize, Mexico (Durango, Guerrero, Jalisco, Puebla, Oaxaca, and Sinaloa), and the United States (Arizona) are described to provide names for a forthcoming revision and phylogenetic analysis of the Berytidae of the world. An illustration of the dorsal habitus, scanning electron micrographs, and diagnostic information are provided for each species to help distinguish these taxa from other New World berytids.

Key Words: Heteroptera, Berytidae, new genera, new species, *Diabolonotus pilosus, Oedalocanthus ornatus,* Belize, Mexico, United States

The two new genera and species presented in this paper are described to provide names for a forthcoming revision and phylogenetic analysis of the berytid genera of the world. Both genera belong to a group that previously would have been included in the subfamily Metacanthinae. However, these two taxa, as well as the majority of other Neotropical genera, comprise a monophyletic group that will be transferred to a new subfamily and tribe to be described in the above-mentioned generic revision.

Abbreviations for institutions cited in the paper are CNC (Canadian National Collection, Agriculture Canada, Ottawa, Ontario); TAM (Texas A&M University, College Station); UNAM (Universidad Nacional Autonoma Mexico, Mexico D.F.) and; USNM (U.S. National Museum of Natural History, Washington, D.C.).

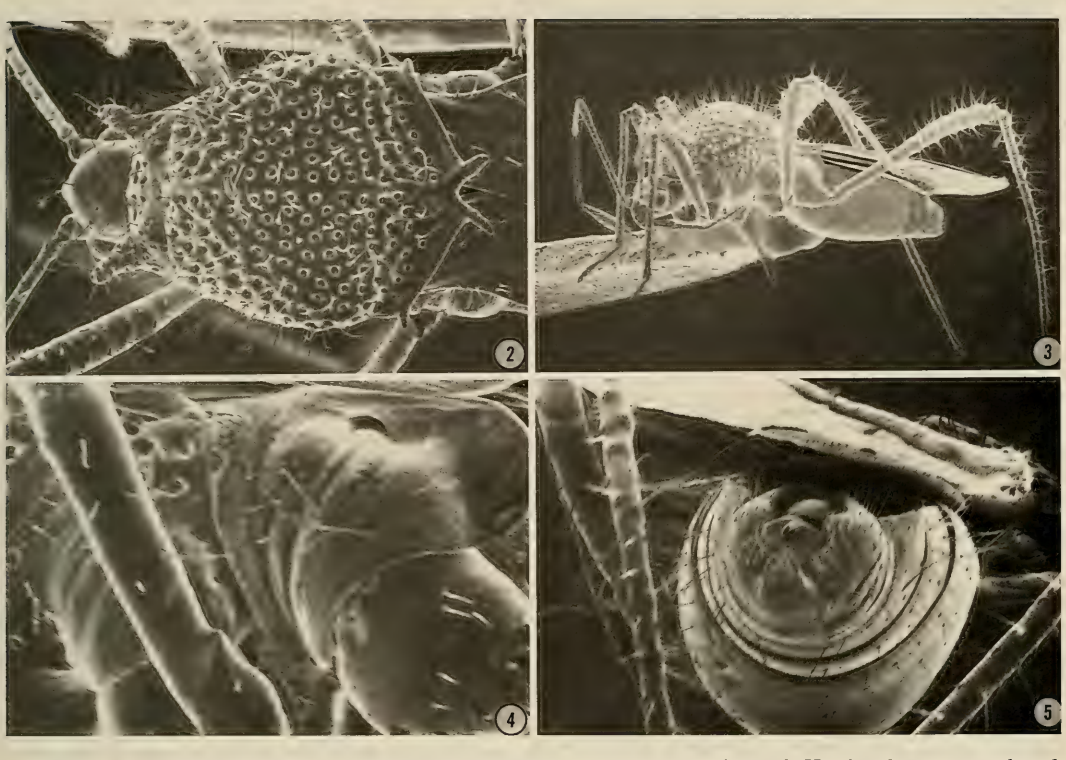
Diabolonotus Henry, New Genus

Type species: *Diabolonotus pilosus* Henry, new species.

Diagnosis.—*Diabolonotus* is most closely related to *Xenoloma* Harris (1943) in sharing a strongly convex pronotum, stout legs, bowed hind femora, widely spaced ocelli, and widely explanate basal margin of the pronotum having a V-shaped process that obscures the scutellum (Fig. 1, 2). It differs, however, in the more slender ostiolar evaporative area that extends from between the meso- and metacoxa to the dorsal edge of the mesopleural area (Fig. 4), the differently shaped metasternum (with rostral groove represented only by a dimpled area at the middle), the 2nd abdominal segment having only a weak indentation on anterior edge (both segments with a broad longitudinal groove in *Xenoloma*), the lack of protuberances on the side of the pronotum, the presence of two long, anteriorly directed, hornlike tubercles on the pronotum (Figs. 1, 2), and the femora and bases of the tibiae with small, setigerous, wartlike tubercles (Fig. 3).

Description.—Length 3.20–3.60 mm.

Fig. 1. Dorsal habitus of *Diabolonotus pilosus*.



Figs. 2–5. Scanning electron micrographs (uncoated) of *Diabolonotus pilosus*. 2, Head and pronotum, dorsal aspect (51.5×). 3, Whole specimen, lateral aspect (18.7×). 4, Ostiolar evaporative area (122×). 5, Male genital capsule, caudal aspect (72.5×).

Head slightly longer than wide, frons and vertex strongly convex, tylus somewhat quadrate in lateral aspect; posterior lobe much lower than level of anterior lobe, giving an almost necklike appearance in lateral aspect, ocelli widely placed in line with inner margin of eyes. Rostrum extending to mesocoxae. Antenna with long pilose setae two or more times longer than segments; segment I longest, somewhat thickened, gradually enlarged to apex; segments II and III most slender, subequal in length; segment IV thickest, fusiform. Pronotum coarsely punctate; anterior lobe with a long, stout, apically blunt tubercle or spine on each side; posterior lobe strongly convex, coarsely punctate, unarmed, lateral carinae indistinct, basal edge explanate, each side with a short spinelike tubercle and middle with a V-shaped process (Fig. 2) extending caudally to obscure scutellum. Hemelytra translucent to hyaline, somewhat subparallel, apically rounded, constricted at bases. Ventral surface: procoxae proximate, meso- and metacoxae widely separated; mesosternum with a wide rostral groove, metasternum with a dimpled groove at middle; abdomen impunctate, 2nd segment quadrate, impressed on anterior margin but without distinct rostral groove. Ostiolar evaporative area (Fig. 4) very narrow, extending from opening between meso- and metacoxae dorsally to near level of hemelytra, without tubercles, channel appearing only as an indistinct line. Legs (Figs. 1, 3) stout, femora and bases of tibiae with small, setigerous, wartlike tubercles; femora gradually enlarged apically, metafemora weakly bowed; claws cleft or toothed basally. Genital capsule generally rounded, impunctate, caudal edge of aperture with a stout, dorsally curved, spinelike tubercle (Fig. 5); para-

meres oblong oval, with a recurved, acute, apical process.

Etymology.—The generic name is taken from the Greek "diabolos," meaning devil and "notum," referring to the pronotum or dorsum of the thorax, and is used to draw attention to the two, anteriorly directed "devil-like" horns or blunt spines on the pronotum. The gender is masculine.

Diabolonotus pilosus Henry, New Species
(Figs. 1–5)

Diagnosis.—*D. pilosus* can be separated from all other New World berytids by the generic characters given above. Additional characters that distinguish this unusual berytid from all others are the shiny black thorax, 1st and 4th antennal segments, and femora, contrasting with the pale, almost white, abdomen showing through the hyaline hemelytral membrane (clavus and corium translucent white), and the strongly pilose body and appendages.

Description.—*Holotype male*: Length 3.20 mm. Generally shiny black, with contrasting pale to whitish hemelytra (Fig. 1). *Head*: Length 0.46 mm, width 0.40 mm, width of vertex 0.28 mm; impunctate, brown to yellowish brown, with fuscous along inner margins of eye on vertex, around antennal bases, and along gular region; eyes and ocelli reddish. *Rostrum*: Length 0.94 mm, extending to bases of mesocoxae. *Antenna*: Segment I, length 0.90 mm, II, 0.56 mm, III, 0.54 mm, IV, 0.48 mm; segment I black, II yellowish brown, black at base, III, yellowish brown, IV black; segments I-III with long, slender setae 2 or more times diameter of segments, setae on segment IV subequal to diameter of segment. *Pronotum* (Fig. 2): Length 1.06 mm (to base of V), basal width 0.82 mm; uniformly shiny black, deeply punctate except for median and indistinct lateral carina, anterior and posterior lobes weakly separated, strongly convex; anterior lobe with a stout, setigerous, apically blunt tubercle or spine at each front angle, the base around each spine swollen; basal margin of posterior lobe widely explanate, each side of base with a short marginal spinelike tubercle and middle with a V-shaped process. *Scutellum*: Reduced, with a small globose tubercle; difficult to see below explanate base of pronotum. *Hemelytron*: Macropterous; membrane hyaline, corium and clavus translucent pale to almost whitish, fuscous across base bordering pronotum, margin of constricted base with several long, erect setae. *Ostiolar area*: evaporative area whitish (Fig. 4). *Ventral surface*: Acetabula, sides of prosternum, and all of mesosternum shiny black, middle of prosternum and metasternum pale or whitish; abdomen with scattered long simple setae, shiny pale yellow to nearly white ventrally (and dorsally), segment II more brown, margined with fuscous. *Legs* (Figs. 1, 2): Femora black, with numerous small, wartlike setigerous tubercles, each tubercle with a long erect seta equal to or longer than femoral diameters; pro- and mesotibiae pale yellowish to white, with basal ⅓ black, metatibiae pale, black on basal half or more, all tibiae with small, wartlike setigerous tubercles on black areas, setal lengths 4 or more times diameter of segments; tarsomeres I and II pale, tarsomere III and claws black. *Femoral lengths*: Pro—0.90 mm, meso—1.04 mm, meta—1.40 mm. *Tibial lengths*: Pro—1.08 mm, meso—1.24 mm, meta—1.94 mm. *Genital capsule* (Fig. 5).

Female (n = 4): Length 3.40–3.60 mm. *Head*: Length 0.46–0.48 mm, width 0.42–0.44 mm, vertex 0.30–0.32 mm. *Rostrum*: Length 1.04–1.06 mm. *Antenna*: Segment I, length 0.90–1.02 mm; II, 0.52–0.60 mm; III, 0.50–0.58 mm; IV, 0.50–0.52 mm. *Pronotum*: Length 1.12–1.16 mm, basal width 0.94–0.96 mm. *Femoral lengths*: Pro—0.90–0.98 mm, meso—1.08–1.16 mm, meta—1.50–1.60 mm. *Tibial lengths*: Pro—1.02–1.20 mm, meso—1.30–1.42 mm, meta—2.06–2.24 mm.

Similar to male in body form and coloration.

Host.—Unknown.

Distribution.—Chiapas, Mexico.

Etymology.—The specific epithet "pilosus" is used to denote the long, fine setae that cover the body and appendages of this species.

Type data.—Holotype: ♂, Mexico, Chiapas, 5 mi. north Nuevo Tenochtitlan, 3000′, 7 August 1990, J. C. Schaffner (USNM). Paratypes: 4 ♀♀, same data as for holotype (3 TAM, 1 USNM).

Oedalocanthus Henry, New Genus

Type species: *Oedalocanthus ornatus* Henry, new species.

Diagnosis.—*Oedalocanthus* can be distinguished from all other Berytidae by the shape of the pronotum having a narrow anterior lobe with five white, ovoid tubercles and two stout, white spines and a strongly convex, punctate posterior lobe with four subtriangular, dorsally curved tubercles or projections along the posterior margin (Fig. 6, 8). It is most similar to *Phaconotus* Harris (1943) in size, general body form, banding on the legs and antennae, shiny head, broadly rounded frons, and ostiolar area. *Oedalocanthus,* in contrast to *Phaconotus,* lacks the small, round, white tubercles on the posterior lobes of the head and pronotum.

Description.—Length 2.48–3.24 mm. Head (Fig. 7) shiny, smooth, impunctate, divided into 2 lobes, anterior lobe with frons and vertex swollen; posterior lobe with 2 widely separated ocelli. Rostrum extending to bases of metacoxae. Antenna long, slender, segment I longest, lengths of II and III about subequal, IV shortest, thickest. Pronotum divided into distinct lobes, narrow anterior lobe punctate along anterior margin, with 2 short, round tubercles on each side and a long stout spine on either side of small, round, median tubercle (Fig. 6, 8); posterior lobe strongly convex, without lateral carinae, punctate, narrowly explanate basal margin with 4 upturned, subtriangular tubercles or projections, one at posterior angle and one on either side of meson; scutellum with a single, stout, erect, cone-shaped spine (Fig. 6). Hemelytra macropterous, slightly constricted at middle and widest on apical ⅓, mostly membranous; pattern of veins as in fig. 6. Venter impunctate. Ostiolar area (Fig. 9) lacking apparent scent channel; represented only by a flat, gray to whitish, subquadrate evaporative area. Legs long, slender; femora swollen apically; femora and tibiae distinctly banded; claws cleft or toothed basally. Genital capsule rounded, impunctate, caudal edge of aperture with a weakly raised median process (Fig. 10); paramere oblong oval with a slender, acute, apical process.

Etymology.—The generic name *Oedalocanthus,* derived from the Greek root "*oidema,*" meaning swelling or tumor, and the Latin "canthus," meaning edge or border (a common generic ending used for berytid names), is used to denote the peculiar white, dorsally curved tubercles or projections along the basal margin of the pronotum. The gender is masculine.

Oedalocanthus ornatus Henry, New Species
(Figs. 6–10)

Diagnosis.—*Oedalocanthus ornatus* is distinguished from all other berytids by the white, rounded and conical tubercles on the anterior pronotal lobe, basal edge of the posterior pronotal lobe, and scutellum (Figs. 6).

Description.—*Male* (n = 10): Length 2.48–2.92 mm. General coloration yellowish brown with the head and posterior lobe of pronotum black. *Head* (Fig. 7): Length 0.42–0.44 mm, width 0.46–0.48 mm, width of vertex 0.24–0.26 mm; anterior lobe shiny black, apex of tylus white, posterior lobe yellow or orange brown. *Rostrum*: Length 1.00–1.02 mm, extending to bases of metacoxae. *Antenna*: Yellowish brown, segments II–III with wide dark-brown bands, segment IV black; segment I length 1.40–1.64 mm, II 0.76–0.80 mm, III 0.78–0.88 mm, IV 0.52–0.54 mm. *Pronotum* (Figs. 6, 8): Length 0.50–0.54 mm, basal

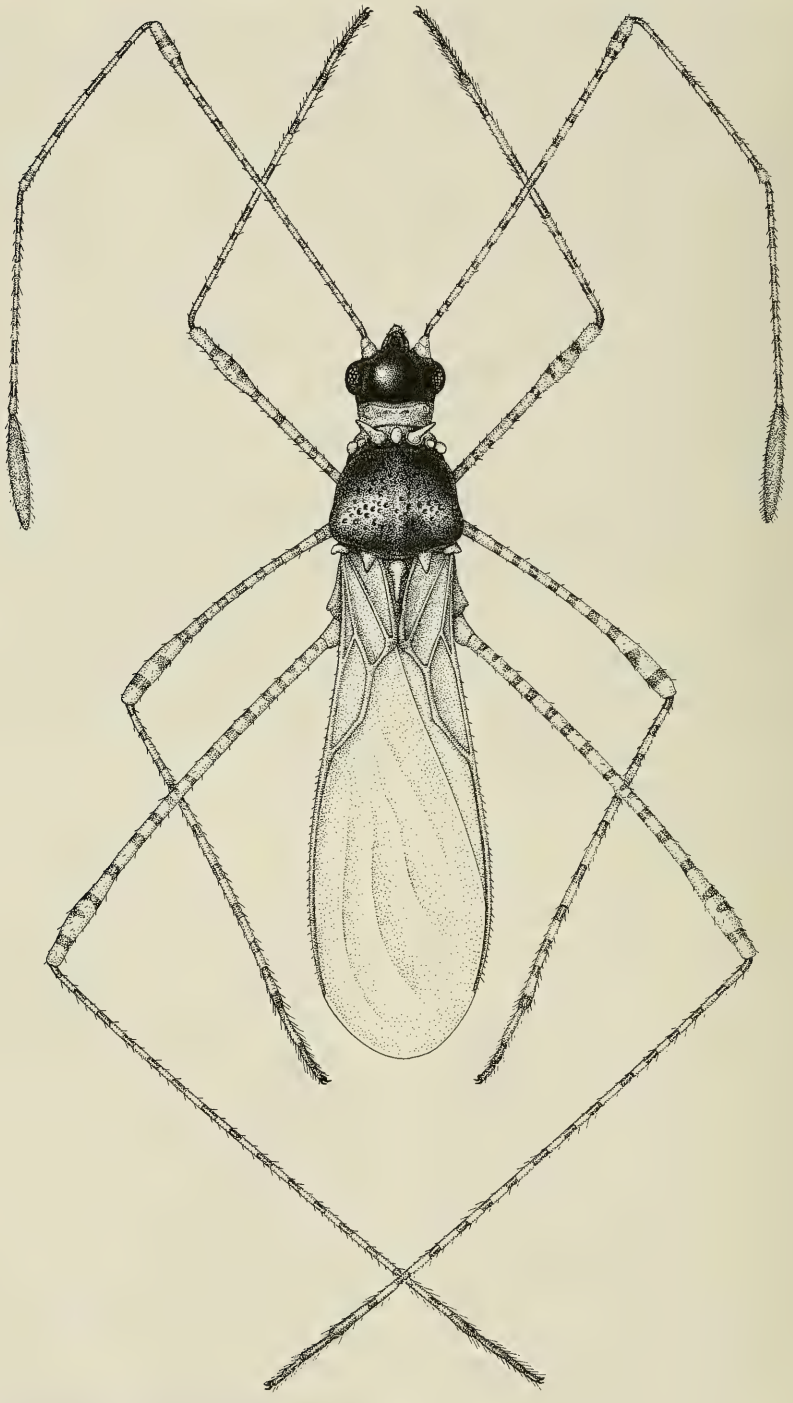
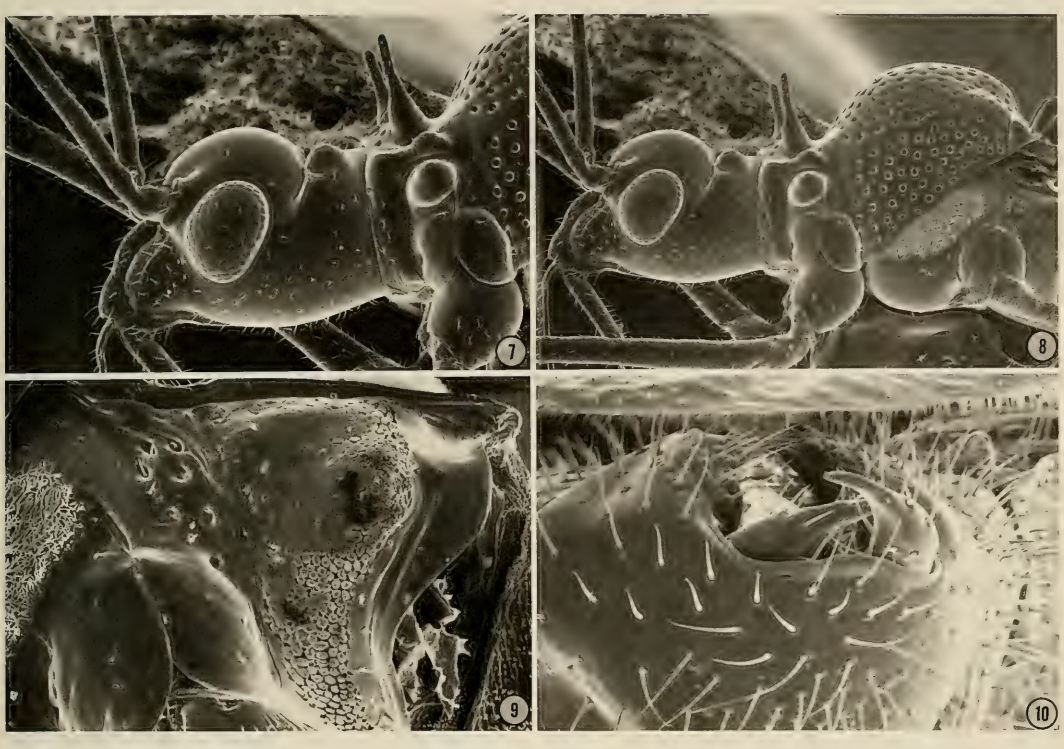


Fig. 6. Dorsal habitus of *Oedalocanthus ornatus*.



Figs. 7–10. Scanning electron micrographs of *Oedalocanthus ornatus*. 7, Head, lateral aspect (99×). 8, Head and pronotum (74.5×). 9, Ostiolar evaporative area (246×). 10, Male genital capsule, caudal aspect (364×).

width 0.46–0.52 mm, shiny black, tubercles white. *Scutellum*: Black, with a relatively slender, erect, conical, white tubercle. *Hemelytron*: Hyaline, veins mostly yellowish brown, inner margin of costal vein fuscous, small area of veins and membrane just posterior to apex of scutellum reddish. *Ventral surface*: Pro- and mesosternum and genital capsule black; abdomen brown. *Ostiolar evaporative area* (Fig. 9): Grayish or whitish). *Legs*: Whitish to yellowish brown, femora and tibiae with wide dark brown bands. *Femoral lengths*: Pro—0.84–0.88 mm; meso—0.96–1.02 mm; meta—1.38–1.60 mm. *Tibial lengths*: Pro—1.02–1.04 mm; meso—1.16–1.20 mm; meta—1.92–2.24 mm. *Male genital capsule*: Fig. 10.

Female (n = 10): Length 2.76–3.24 mm. *Head*: Length 0.42–0.48 mm, width 0.40–0.44 mm, vertex 0.28–0.30 mm. *Rostrum*: Length 1.14–1.24 mm. *Antenna*: Segment I, length 1.64–1.88 mm; II, 0.82–0.98 mm; III, 0.88–1.06 mm; IV, 0.60–0.62 mm. *Pronotum*: Length 0.50–0.68 mm, basal width 0.48–0.64 mm. *Femoral lengths*: Pro—0.96–1.18 mm; meso—1.06–1.34 mm; meta—1.64–1.96 mm. *Tibial lengths*: Pro—1.12–1.30 mm; meso—1.30–1.58 mm; meta—2.34–2.72 mm.

Very similar to male in coloration and general body structure.

Host.—Two specimens were collected on *Desmodium* sp. [Fabaceae]. A series from Jalisco, Mexico, was collected on a low-growing plant with red flowers (H. Brailovsky, pers. comm.).

Distribution.—Belize, Mexico (Chiapas, Durango, Guerrero, Jalisco, Oaxaca, Puebla, and Sinaloa), and the United States (Arizona).

Etymology.—The specific epithet *ornatus,* Latin for handsome or splendid, indicates the attractiveness of this berytid's

brown-banded appendages and black pronotum adorned with white tubercles.

Type data.—Holotype: male, Mexico, Jalisco, Melaque, 8-VIII-85, H. Brailovsky [on low-growing plant with red flowers] (UNAM). Paratypes.—Belize: 1 ♂, 15 mi. W. Belize C., 9 Aug. 1974, D. Engleman (USNM). Mexico: 4 ♂♂, 3 ♀♀, Chiapas, Arriaga, 4 Aug. 1969, L. A. Kelton (CNC, USNM); 1 ♂, 10 mi. W. El Salto, Durango, Mexico, 9000′, 3 Aug. 1964, L. A. Kelton (CNC); 2 ♂♂, Guerrero, Acapulco, La Pinzona, 1 Oct. 1986, H. Miranda, taken on *Desmodium* sp. (USNM); 1 ♂, Guerrero, Iguala, Teucizapan, 6-III-87, E. Barrera (UNAM); 11 ♂♂, 12 ♀♀, same data as for holotype (UNAM, USNM); 5 ♂♂, 18 ♀♀, Puebla, Calipan, 4-XI-1988, R. Barba, E. Barrera, L. Cervantes (UNAM, USNM); 2 ♀♀, Puebla, Tehuacan, on road to Oaxaca, 11 Oct. 1979, E. Barrera (UNAM, USNM); 2 ♀♀, Tehuantepec, Oaxaca, 9 Sept. 1979, E. Barrera (UNAM); 1 ♀, Sinaloa, 20 mi. S. E. Rosario, 20 Aug. 1964, H. R. Burke and J. Apperson (TAM). United States: 1 ♀, Arizona, Cochise Co., Rustler's Park, 10 mi. W. Portal, ca. 8000′, 3-IX-1991, E. E. Grissell (USNM).

Acknowledgments

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98(3), 1996, pp. 541–550

A NEW GENUS OF NEOTROPICAL COCCINELLINI (COLEOPTERA: COCCINELLIDAE) RELATED TO *OLLA* CASEY AND ALLIES

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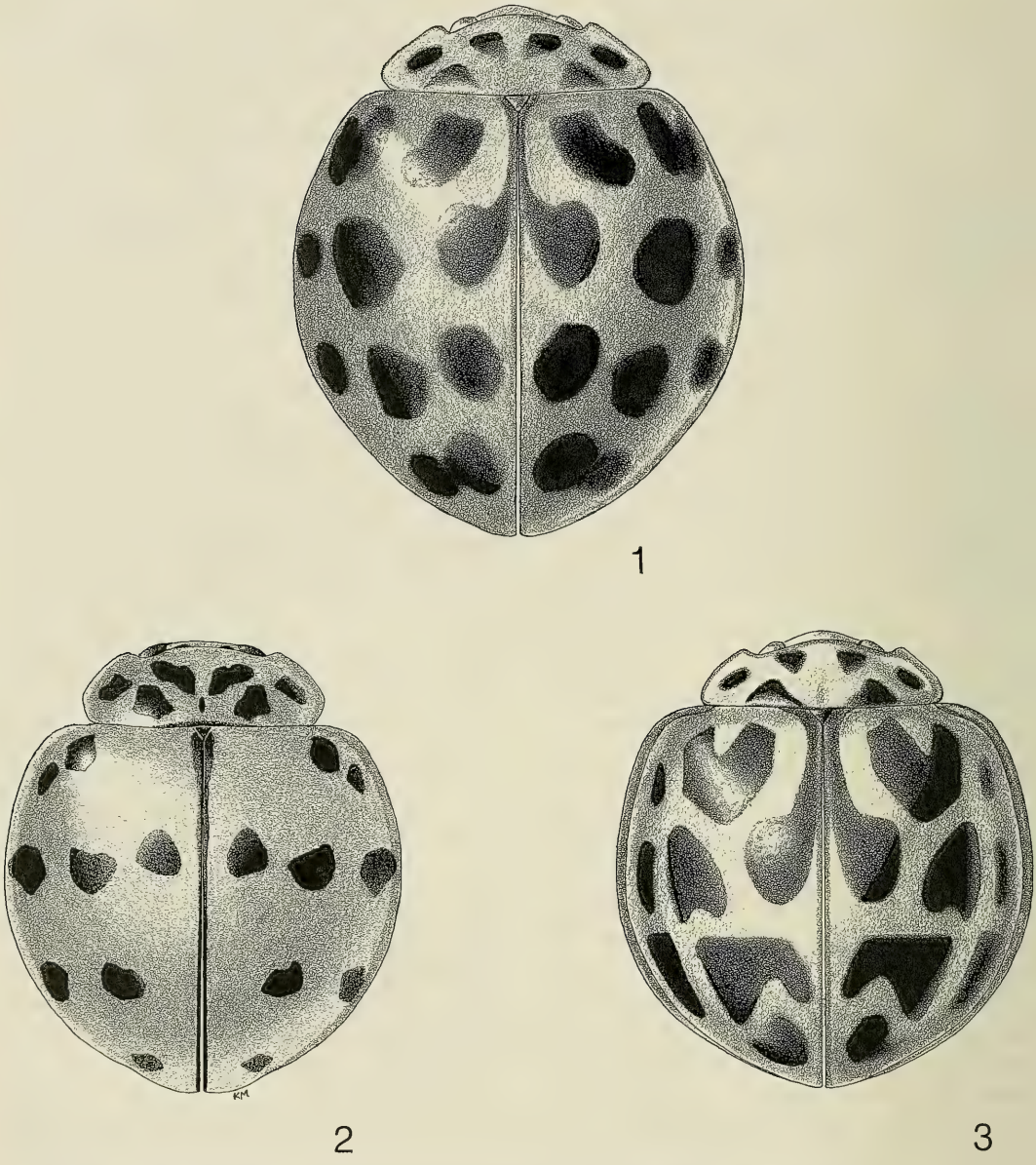
Abstract.—***Spilindolla,*** a new genus of Neotropical Coccinellini, is proposed to accommodate the species *Cycloneda vigintiduonotata* (Mulsant), *C. darestei* (Mulsant) and *Egleis constellata* Mulsant. These three species constitute **new combinations** within *Spilindolla.* The new genus is most closely allied to *Spiloneda* Casey and belongs to a subgroup of nine other genera within the neotropical coccinelline fauna informally designated as "*Olla* and allies." *Spilindolla* is compared to related as well as superficially similar genera. The species are described, keyed and illustrated and their distributions given.

Key Words: Coleoptera, Coccinellidae, predator, new genus, Neotropical

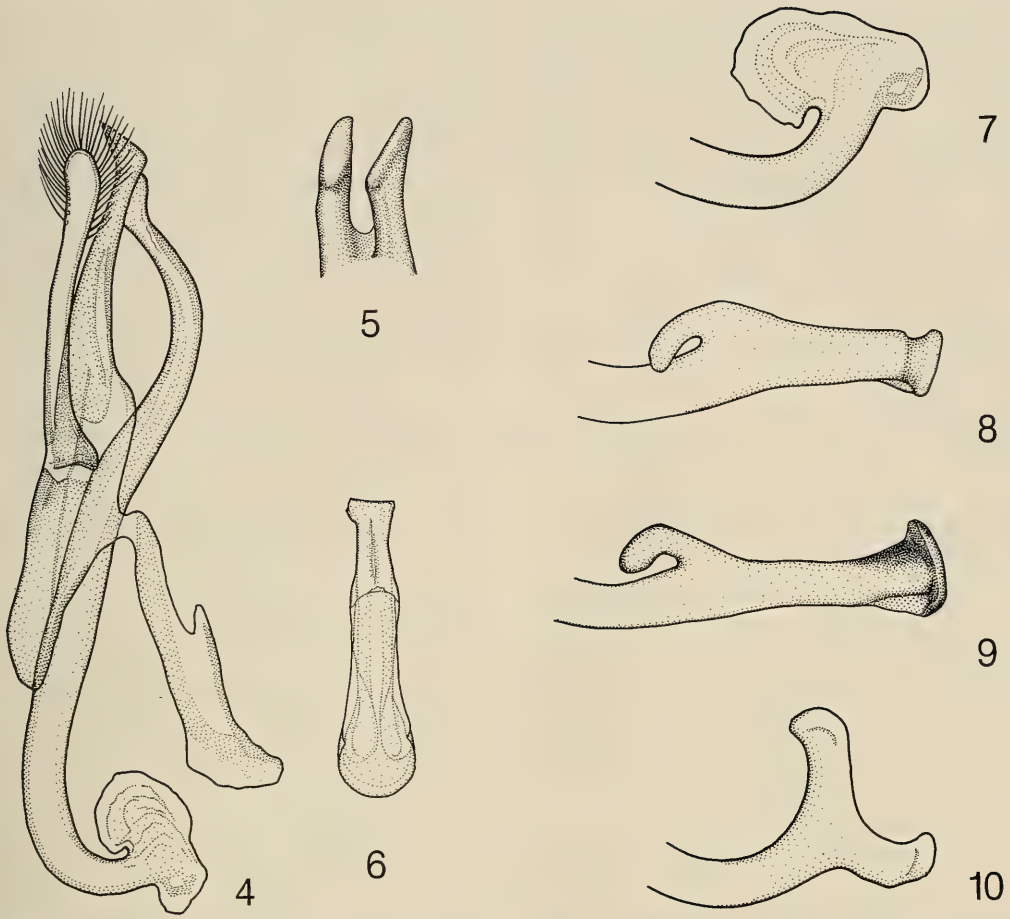
Although the Coccinellini constitute one of the better known tribes of lady beetles, the Neotropical components of the fauna are still poorly characterized. This is true despite the fact that coccinellines are often imported for use in the biological control of exotic Homoptera, and the Neotropics are a popular source area in the exploration for biological control agents. The present work proposes a new genus to accommodate three misclassified species of Neotropical Coccinellini: *Cycloneda vigintiduonotata* (Mulsant) (Fig. 1), *C. darestei* (Mulsant) (Fig. 3) and *Egleis constellata* Mulsant (Fig. 2). Vandenberg (1987) discovered the new taxon while studying type material of *Cycloneda* as part of a doctoral thesis project. *Egleis constellata* is reassigned to the new genus on the basis of notes and sketches made by the second author from type material in the Paris museum. The new genus falls within the lineage of "*Olla* and allies" (Vandenberg 1992), regarded as a monophyletic assemblage of primarily Neotropical Coccinellini comprising *Olla* Casey, *Cirocolla* Vandenberg, *Spiloneda* Casey, *Paraneda* Timberlake, *Clynis* Mulsant, *Neda* Mulsant, *Mononeda* Crotch, *Neoharmonia* Crotch and *Procula* Mulsant. This group is united by the following genital characteristics: Male with siphonal apex tubular or tapered, lacking a membranous pouch and spicules, but often with preapical projections or lobes (Figs. 22–24); siphonal capsule with inner and outer arms dissimilar in size and or shape (Figs. 7–9); basal lobe generally apically bifurcate (Figs. 19–21); basal piece often highly elongate. Female genitalia with sperm duct unmodified or with a portion forming a simple tubular sheath (Figs. 11–13).

Members of the new genus can be distinguished from related genera by certain unusual features of the male genitalia, in particular the ventrally keeled apex of the basal lobe (Fig 5), and the recurved sipho (Figs. 4, 22–24) with a laterally warped siphonal capsule bearing a reduced outer arm (Fig.



Figs. 1–3. Adult habitus. 1, *Spilindolla vigintiduonotata.* 2, *S. constellata.* 3, *S. darestei.*

7). The female genitalia (Fig. 11) are distinguished by the combined characteristics of a very short sperm duct arising distally from a robust plicate bursa, and paddle shaped genital plates with a highly elongated inner "handle". The adult beetles have a very compact, "broad-shouldered" look (Figs. 1–3) which is fairly distinctive (width of elytral base much greater than pronotal width). In addition, they can be recognized (Fig. 15) by the straight to weakly curved posterior margins of abdominal segments 1–4, the configuration of the postcoxal line (with linear conjoined oblique line) and the notched apex of abdominal segment 6 in males. The presence of a pair of tibial spurs on the middle and hind legs is also useful for distinguishing



Figs. 4–10. Male genitalia. 4–6, *Spilindolla vigintiduonotata.* 4, Whole dissection, lateral view. 5, Apex of basal lobe ventrolateral view. 6, Trabes, ventral view. 7–10, Siphonal capsules, lateral view. 7, *S. vigintiduonotata.* 8, *Spiloneda* sp. 9, *Mononeda* sp. (*Neda* group). 10, Undescribed species (*Egleis* and allies).

this genus from the similar appearing *Egleis.*

Label data are quoted verbatim for all available type specimens, but locality records only are cited for nontype material examined during the study. The known distribution of the new genus includes Panama, northern South America and southern Brazil. Specimens are rarely collected so that the actual distribution and species count may prove to be far greater than that presented here. Nothing is currently known of the habitat and prey preferences of the three species presently comprising the new genus, but the allied genus *Olla* contains species which are primarily psyllid and aphid feeders, with a preference for arboreal habitats or shrubs (Vandenberg 1992). Depositories of type and other material examined are specified using the abbreviations listed in Acknowledgments.

Spilindolla Vandenberg, New Genus
(Figs. 1–6, 11, 15–24)

Type species.—*Daulis vigintiduo-notata* Mulsant

Description.—Length 4.0 to 6.5 mm. Form compact, broadly oval, pointed posteriorly, subhemispherical to suprahemispherical with weakly explanate lateral margins (Fig. 17). Punctation on dorsal surface

dense and fine; coarser, more widely spaced punctures present just before and within translucent outer margin of elytron; surface between punctures distinctly shagreened. Dorsal color pattern of known species with background ivory to yellowish orange with many brown to black marks (Figs. 1–3). Venter ivory to dark brown, often marked with black or creamy white.

Eyes finely facetted, separated by slightly more than twice diameter of an eye; inner orbits parallel to weakly divergent dorsally. Pronotum convex, lateral margins narrowly reflexed; lateral and basal margins strongly rounded in outline (Fig. 17). Elytron with translucent outer margin explanate along entire length; width of explanate margin decreasing from near apical ⅓ to apex; extreme outer margin with fine raised ridge along entire length; elytral base broad relative to pronotal base (Figs. 1–3). Antenna with length approximately equal to distance between eyes, terminating in a compact 3-segmented obtriangular club. Terminal segment of maxillary palpus small and robust. Intercoxal process of prosternum with pair of convergent carinae reaching 4/5 distance to anterior margin. Mesosternum with small but distinct emargination at middle of anterior border. Elytral epipleuron (Fig. 18) strongly concave and steeply descending externally, faintly foveate for reception of hind femur, maximum width equal to approximately 1/5 width of body at base of abdomen. Middle and hind tibiae each with 2 apical spurs. Tarsal claw moderately long, slender, with subquadrate basal tooth; claws of fore, middle and hind tarsus of approximately equal length. Abdomen (viewed from beneath) as in Fig. 15; widest near middle of 1st through 2nd segments; form shorter in male than in female. First abdominal segment approximately 1 ⅓ times longer along midline than minimum distance between hind coxae; postcoxal line curved posterolaterad, closely paralleling posterior margin for much of its length, becoming less distinct as it reaches lateral margin; oblique line nearly linear, joined to main curve of postcoxal line but less distinct at point of union than at middle of segment. Abdominal segments 1–4 with hind margins linear to weakly curved. Male with 5th abdominal segment truncate or shallowly, roundly emarginate, exposing 6th; 6th segment with small v-shaped emargination at middle of hind margin but often obscured by brush of golden setae. Female with hind margin of 5th abdominal segment rounded (Fig. 16), covering most of 6th; hind margin of 6th segment lacking emargination. Male genitalia with basal lobe divided at apex (Figs. 19–21); apical projections tapered, sharply upturned in lateral view, strongly keeled beneath (Fig. 4, 5); ventral membrane restricted to basal ⅓. Paramere slightly shorter than basal lobe. Trabes robust (Fig. 4, 6), not laterally compressed. Sipho highly modified: main curve s-shaped in lateral view (Figs. 4, 22–24) with terminal gonopore; capsule (Fig. 7) irregularly obtriangular, bowed; outer arm of capsule short, difficult to differentiate from inner arm; inner arm large, forming main body of capsule; ejaculatory duct never extended beyond siphonal apex. Female genitalia (Fig. 11) with weakly curved cornu; distinct ramus with moderately small accessory gland; undifferentiated nodulus set into concavity in lower part of spermatheca; sperm duct very short, attached to distal end of bursa; bursa robust, horizontally plicate.

Etymology.—The generic name reflects the relationship between the new genus and *Olla.* Derived from a contraction of the terms "spilos" (spot) + "linda" (beautiful) + *Olla.* Gender feminine.

Remarks.—*Spilindolla* shows the greatest affinity to the monotypic genus *Spiloneda* (which will soon be expanded to include a half dozen additional species, Vandenberg, in prep.). The close relationship between *Spilindolla* and *Spiloneda* can be seen in the similar body shape, the slightly foveate elytral epipleuron (usually highlighted with a dark spot) (Fig. 18), the warped siphonal capsule of the male geni-

talia (Figs. 7, 8), and the very short sperm duct attached distally to the bursa in the female genitalia (Fig. 11). *Spilindolla* differs in possessing a more derived form of the male genitalia (Figs. 4–6), especially the recurved sipho, keeled basal lobe, reduced ventral membrane, and robust trabes. Externally *Spilindolla* differs from *Spiloneda* in the slightly larger body size, the shape and contours of the abdominal segments, the form of the postcoxal line (curved in *Spiloneda*), and in possessing more widely spaced eyes.

Olla and *Cirocolla* also share many affinities with *Spilindolla,* but they possess much longer sperm ducts in the female genitalia, which attach mediodorsally or basally rather than distally (Fig. 12).

The remaining genera comprising "*Olla* and allies" are more distantly related. Many species currently classified in *Cycloneda,* but more properly allied to *Neda,* bear a strong superficial resemblance to the three *Spilindolla* species, but the males show the more elongate, trumpet like configuration of the outer arm of the siphonal capsule (Fig. 9), and the females exhibit the greatly enlarged spermathecal accessory gland, pronounced development of the nodulus and more robust sperm duct (Fig. 13). These characteristics are shared by a subgroup of "*Olla* and allies" including *Neda, Mononeda, Neoharmonia,* and the misclassified *Cycloneda* species which constitute additional undescribed genera.

Key to Species of *Spilindolla*

1. Elytral color pattern consisting of irregular angulate brown marks on a paler background (Fig. 3). Male genitalia with basal lobe broadest in distal ¼ (Fig. 21) . . . . . *darestei* (Mulsant)
– Elytral color pattern consisting of oval to punctiform brown or black spots on a paler background (Figs. 1, 2). Male genitalia with basal lobe broadest near middle (Figs. 19, 20) 2
2. Dorsal surfaces yellowish orange. Fully maculate individuals with 11 elytral spots arranged in rows of 3-3-3-2 as shown (Fig. 1); some spots occasionally fused. Male genitalia as in Figs. 19, 22 . . . *vigintiduonotata* (Mulsant)
– Dorsal surfaces yellowish ivory. Fully maculate individuals with 8 elytral spots arranged 2-3-2-1 as shown (Fig. 2). Male genitalia as in Figs. 20 and 23 . . . . . *constellata* (Mulsant)

Spilindolla vigintiduonotata (Mulsant), New Combination

(Figs. 1, 4–7, 11, 15–19, 22)

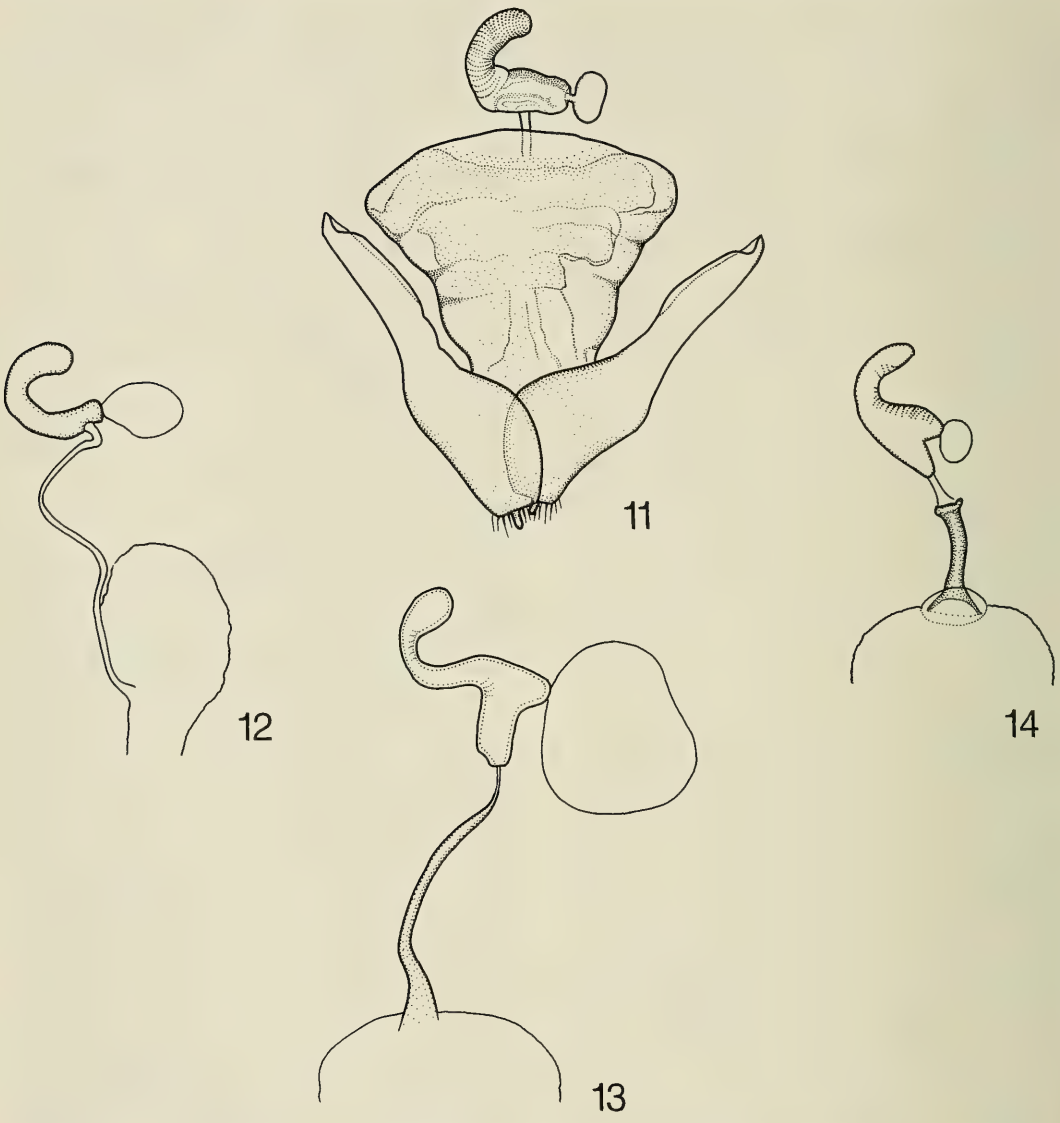
Daulis vigintiduo-notata Mulsant 1850:307.
Leis vigintiduo-notata: Mulsant 1866:180.
Cycloneda vigintiduo-notata: Crotch 1871: 6; 1874:162.
Cycloneda vigintiduonotata: Korchefsky 1932:287; Blackwelder 1945:453; Mader 1958:245; Gordon 1987:20.

Female (lectotype).—Length 5.6 mm, width 4.5 mm. Form slightly elongate, suprahemispherical. Dorsal color pattern as in Fig. 1. Ground color yellowish orange with dark brown marks. Head immaculate. Pronotum with 6 marks. Scutellum dark brown. Elytron with 11 marks arranged in rows of 3-3-3-2: in 1st row, humeral and humerolateral marks confluent; in 2nd row, outer most mark touching lateral margin, inner most mark touching suture and extended anteriorly to basal margin as narrow border; in 4th row, marks weakly confluent. Sutural and lateral margins of elytron translucent amber. Venter, including legs, primarily light golden brown; metasternum and metepisternum, median ⅘ of 1st through 3rd abdominal segments, and lateral mark on each side of 4th abdominal segment dark brown; elytral epipleuron pale yellowish with dark brown spot at fovea.

Female genitalia.—Fig. 11.

Male.—Same as female except for sexual characters. Genitalia (Figs. 4–6) with basal lobe broadest near middle, outline as shown (Fig. 19); sipho as in Fig. 22.

Variation.—Length 4.0 to 5.8 mm. Form often less elongate than in lectotype. Scutellum dark brown to yellowish orange. Dorsal marks light brown to dark brown; smaller or larger than in lectotype; confluent marks sometimes discrete; inner mark of 2nd row not always touching suture; out-

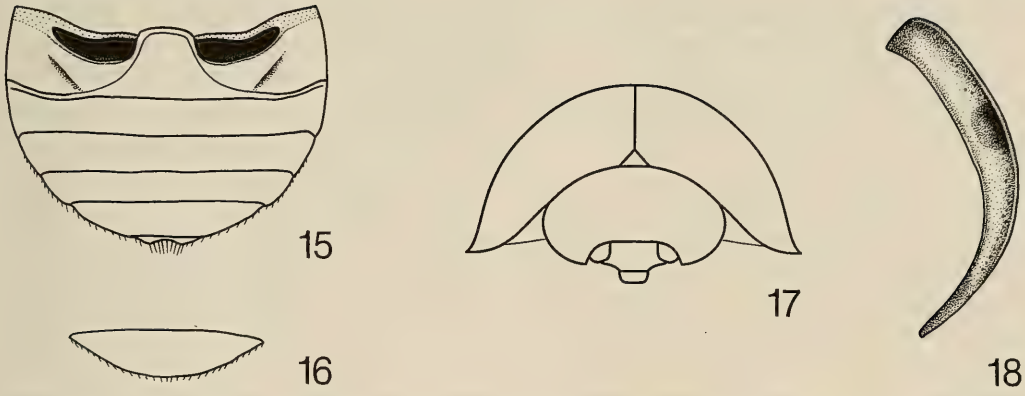


Figs. 11–14. Female genitalia. 11, *Spilindolla vigintiduonotata.* 12, *Olla* sp. 13, *Neda* sp. 14, *Cycloneda* sp.

er mark of 2nd row not always touching lateral margin. Venter with mesosternum light brown to blackish; pronotal hypomeron, pro- and mesosternum, mes- and metepimeron often creamy white; abdomen with dark brown areas greater or less than in lectotype, sometimes entire abdomen unicolorous dark brown.

Type material.—LECTOTYPE (by present designation)(DLM): female, "Coccinella 22 notata. mihi./L. Cayennae D. Banon [green header label in box, not affixed to specimen]."

Remarks.—*Spilindolla vigintiduonotata* can be easily distinguished from its congeners by the species specific dorsal color pattern; it is most similar to *S. constellata,* but has the ground color more orangy and has larger more numerous elytral spots. Males of *S. vigintiduonotata* can also be distinguished by the shape of the basal lobe (Fig. 19) and siphonal apex (Fig. 22). *Cy-*



Figs. 15–18. *Spilindolla vigintiduonotata,* external morphology of adult. 15, Ventral view of male abdomen. 16, Ventral view of female abdominal segment 5. 17, Frontal view of whole body. 18, Ventral view of elytral epipleuron.

cloneda sallei (Mulsant) somewhat resembles this species, but has a narrower base to the elytron, and differs in the arrangement of the dorsal marks, in the proportions and contours of the abdominal segments (base of 4th segment strongly bowed), and in the genitalia of both sexes. *Cycloneda sallei* is another misplaced species which shows a strong affinity to *Neda.*

Mulsant based his original description of *Daulis vigintiduo-notata* on material from the collections of Dejean and Chevrolat. The specimen designated as lectotype was located in the Dejean collection of the Museum d'Histoire Naturelle, Lyon, France; the header label (see above) specifies the locality of Cayenne given in the original description. A second specimen marked "Chevr." was found among the material acquired by Crotch and currently housed at the University of Cambridge. Mulsant specified that the material from the Chevrolat collection was from "Chili" and "Nouvelle Hollande" (= Suriname?), but the example in the Crotch collection does not specify a collection locality and therefore is not designated as a paralectotype. The locality "Chili" is in need of corroboration and may be the result of mislabeling or misassignment of localities.

Mulsant (1850) originally described *S. vigintiduonotata* in *Daulis* along with more than thirty other named species. Subsequently (Mulsant 1866) he transferred this species to *Leis* Mulsant based on the contours of the elytra. Currently *Leis* is placed as a synonym of *Harmonia* Mulsant, a genus of Oriental and Australian lady beetles which bear little affinity to the species in question. Crotch (1871) and subsequent authors have all classified *vigintiduonotata* in *Cycloneda,* although most have recognized this genus as a composite of unrelated species. *Cycloneda,* sensu stricto, has a well developed infundibulum on the sperm duct of the female genitalia (Fig. 14) and the male genitalia terminate in a membranous pouch and spicules. More extensive diagnoses of *Cycloneda* and allied fauna can be found in Vandenberg and Gordon (1988), Vandenberg (1992) and Gordon and Vandenberg (1993) (larvae).

Locality data.—26 specimens examined. BOLIVIA: Guayaramerida: Beni, outskirts of town. BRASIL: Santa Catarina: Blumenau; Corupa (Hansa Humbolt). [CHILE: "Chili"?] COLOMBIA: Cauca: "Cauca." FRENCH GIUANA: Guyane: Cayenne. PANAMA: "Pacora." Canal Zone: Pipe Line rd. nr. Gamboa. SURINAME: Suriname: Paramaribo. VENEZUELA: Merida: Briceno; "Meride"; Zulia, 31 km SW Machiques. (BMNH) (DLM) (HNHM) (LSUC) (MNHP) (CUMZ) (USNM).

Spilindolla constellata (Mulsant), New Combination
(Figs. 2, 20, 23)

Egleis constellata Mulsant 1850:155; 1866: 121; Crotch 1871:4.

Male (holotype).—Length 5.5 mm, width 4.8 mm. Form slightly elongate, subhemispherical. Dorsal color pattern as in Fig. 2. Ground color yellowish ivory with black marks. Head with pair of elongate black marks that converge slightly toward apex. Pronotum with 6 punctiform spots as shown, posterior margin narrowly piceous. Scutellum blackish. Elytron with 8 punctiform marks arranged in rows of 2-3-2-1; anterior and sutural margins narrowly piceous, lateral margins paler amber. Venter, including legs, primarily yellowish ivory, borders of sclerites amber to piceous; mes- and metepimera, metepisternum somewhat paler yellowish ivory; abdominal segments 1–3 with dark punctiform spot on each side; epipleuron immaculate. Genitalia with basal lobe broadest near middle, configuration as shown (Fig. 20); sipho as in Fig. 23.

Female.—Same as male except for sexual characters. Genitalia similiar to those of *S. vigintiduonotata.*

Variation.—Length 5.0 to 5.7 mm, width 4.3 to 5.2 mm. Scutellum occasionally pale. Pronotum occasionally with additional short upright basomedial black mark. Elytron with inner mark of basal row sometimes transversely crescentiform, extended toward suture; outer mark of 2nd row sometimes reaching lateral margin. Venter often with additional dark marks on epipleural fovea, mes- and metepisterna, metasternum, each side of abdominal segment 4, and posterior margin of mes- and metacoxa.

Remarks.—This species is most closely related to *S. vigintiduonotata* (see discussion under the "remarks" section for the latter species). It has been misclassified in *Egleis* since Mulsant first described it in 1950, but the resemblance is a superficial one based on the pale, spotted habitus. *Egleis* and close allies lack tibial spurs on the middle and hind leg, have even more finely facetted eyes, a less compact antennal club with terminal segment more oval shaped, and generally have the pronotum less convex and the prosternum more convex (lateral arms of T-shaped prosternum more strongly folded back from midline) given a prothorax of comparable thickness. The male genitalia of *Egleis* and allies (Vandenberg 1992) have an undivided basal lobe, a simple curve to the main body of the sipho, and a weakly s-shaped siphonal capsule with inner and outer arms subequal (Fig. 10). The female genitalia of *Egleis* have the genital plates more diamond shaped with a shorter inner "handle."

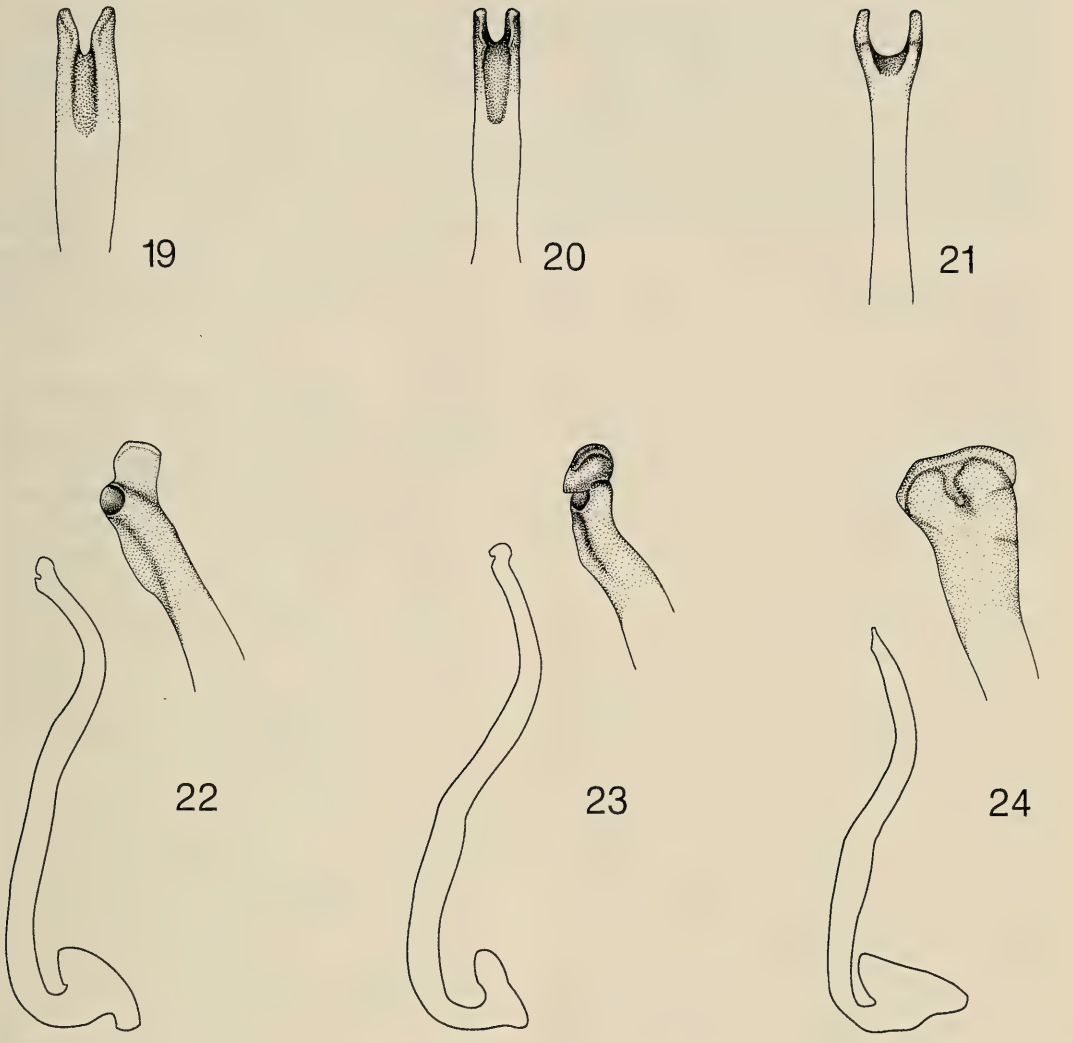
Type material.—HOLOTYPE (MNHP): male "Museum Paris, Matto-Grosso, de Castelnau 3-47/55/Egleis constellata Muls., auct. det."

Locality data.—21 specimens examined. BRASIL: Mato Grosso: Barre do Tapirape; "Matto-Grosso." Mato Grosso do Sul: Corumba. (CMP) (CAS) (IZPAN) (MNHP).

Spilindolla darestei (Mulsant), New Combination
(Figs. 3, 21, 24)

Daulis Darestei Mulsant 1866:228.
Cycloneda Darestei: Crotch 1871:6; 1874: 165; Korchefsky 1932:283; Mader 1958: 243.
Cycloneda darestei: Blackwelder 1945:452.

Male (lectotype).—Length 4.5 mm, width 4.5 mm. Form hemispherical. Dorsal color pattern as in Fig. 3. Ground color yellowish ivory with light brown marks. Head immaculate. Pronotum with 7 marks (Fig. 3); median basal mark indistinct. Scutellum light brown. Elytron with 8 irregular, angular marks as shown; inner most mark just before middle of elytron continued anteriorly to basal margin as sutural border. Sutural and lateral margins of elytron translucent amber. Venter, including legs, primarily light golden brown; prosternum, mes- and metepimeron, and metepisternum whitish cream with fine brown borders;



Figs. 19–24. Male genitalia. 19–21, Basal lobe. 19, *Spilindolla vigintiduonotata.* 20, *S. constellata.* 21, *S. darestei.* 22–24, Lateral view of whole sipho (below) and detail of apex (above) (note: detail of apex rotated 90 degrees in Fig. 24 to provide homologous view). 22, *S. vigintiduonotata.* 23, *S. constellata.* 24, *S. darestei.*

pronotal hypomeron and elytral epipleuron same color as dorsal surface; fovea of elytral epipleuron marked with a brown spot. Genitalia as in Figs. 21, 24.

Female.—Same as male except for sexual characters. Genitalia not examined.

Type material.—LECTOTYPE (Gordon 1987) (CUMZ): male "type [blue label]/Darestei Ega Bates [green label]/type Darestei Backw"; PARALECTOTYPE (Gordon 1987) (CUMZ) "Darestei Ega Backw."

Variation.—Length 4.3 to 4.8 mm, width 4.2 to 4.8 mm. Ground color of dorsal surface yellow ivory to light yellowish brown. Dorsal marks at middle of elytron sometimes confluent.

Remarks.—*Spilindolla darestei* can be easily distinguished from its two congeners on the basis of the dorsal color pattern (Fig. 3) and male genitalia (Figs. 21, 24). *Cycloneda graphiptera* (Mulsant) has a dorsal color pattern which is similar to *S. darestei,* but it can be distinguished by the absence

of a humerolateral mark on the elytron and slight differences in the shapes and positions of the other elytral marks. Also *C. graphiptera* has very different contours and proportions to the abdominal segments, with the hind margin of segment 4 strongly bowed. The genitalia of *C. graphiptera* reveal its close affinity to *Neda.*

Spilindolla darestei was originally described in the genus *Daulis* Mulsant. Crotch replaced *Daulis* Mulsant with *Cycloneda* Crotch because the old name was preoccupied by *Daulis* Erichson (1842). This species has remained in the genus *Cycloneda* up until the present revision.

Locality data.—2 Specimens examined. Known only from the type locality. BRASIL: Amazonas: Ega.

Acknowledgments

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THE GENUS *GOERA* (TRICHOPTERA: GOERIDAE) IN CHINA

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Abstract.—Seven new species of the genus *Goera* Stephens from China are described: ***Goera arcuata, G. bicuspidata, G. morsei, G. ramosa, G. redacta, G. spinosa,*** and ***G. spiralis.*** Some of these species and some of the eleven species already described from China are placed in two previously defined and one newly defined species group. Possible relationships of the unassigned species are suggested. *Goera interrogationis* Botoşăneanu, previously known only from Korea, is herein reported from the northeastern Chinese provinces of Hei-long-jiang and Ji-lin. Males of *G. armata* Navás, *G. interrogationis* Botoşăneanu, *G. martynowi* Ulmer, and *G. altofissura* Hwang (= Huang) are redescribed. Females of *G. interrogationis, G. martynowi,* and *G. altofissura* are described for the first time.

Key Words: Caddisflies, Trichoptera, Goeridae, *Goera,* China, new descriptions, new species groups

Goera Stephens (1829) is the largest genus in the family Goeridae and is represented by 107 described species. Recently, Gall (1994) presented a phylogenetic analysis of Goeridae and a revision of the world genera. *Goera* has essentially a Laurasian distribution (Gall 1994), with the greatest diversity in the Oriental region (Malicky and Chantaramongkol 1992). Schmid (1991) described 21 new species from India, Malicky and Chantaramongkol (1992) described 15 new species from southeast Asia, including 10 from Thailand.

Eleven species were previously described from mainland China: *Goera altofissura* Hwang (= Huang), 1957; *G. armata* Navas, 1933; *G. clavifera* Schmid, 1965; *G. crassata* Schmid, 1965; *G. digitata* Martynov, 1931; *G. fissa* Ulmer, 1926; *G. foliacea* Schmid, 1965; *G. latispina* Schmid, 1965; *G. martynowi* Ulmer, 1932; *G. quadripunctata* Schmid, 1959; and *G. tecta* Schmid, 1965. In addition, three species are known from Taiwan: *G. minuta* Ulmer, 1927; *G. prominens* Ulmer, 1911; and, *G. tenuis* Ulmer, 1927; and, two species from Korea: *G. interrogationis* Botoşăneanu, 1970 and *G. japonica* Banks, 1906.

Seven unknown species were identified from specimens collected in China during 1990 and 1991. These bring the total number of known species in the genus to 114. To date, only two species groups, *Goera raghu* Group (Schmid 1991) and *G. minor* Group (Malicky and Chantaramongkol 1992) have been defined. In the process of placing these new species within the genus, one new species group is proposed. The group relationships of some of the remaining species are suggested. A complete examination of the genus worldwide, including a phylogenetic analysis, is planned

for the near future by B. Armitage (Ohio Biological Survey) and W. Gall (Buffalo Museum of Science).

Male genitalia in the genus *Goera* exhibit diversity in the presence and absence of various associated structures, in their development, and in their elaboration. Segment IX exhibits a range of forms including upright and continuous from dorsum to venter, reclined and continuous, or reclined with the subventral portion absent. Tergum X generally bears median dorsal and ventrolateral processes. These latter were described by Schmid (1983) as belonging to tergum IX. The median dorsal processes can be absent or represented by a simple elongate lobe with a rounded apex. There is generally a pair of ventrolateral processes. These processes are represented by a similar range of variability, including multiple branching. When the median dorsal processes is absent, the ventrolateral processes assume a more dorsal position. The preanal appendages are the least variable genitalic structure, typically represented by elongate, cylindrical lobes with rounded apices. The inferior appendages demonstrate the most variability. The distal segment is reduced, often fused with the basal segment, and usually produced into a dorsal lobe of varying length, directed posteriad. An inner, mesal process of the distal segment is usually present, but not always directly associated. The reduction in the distal segment has resulted in this inner process often being located at the junction of the basal and distal segments. There is much variation among species in the length and shape of either portion of the distal segment. The basal segment is large and bears one or two processes of varying length. In species in which the subventral portion of segment IX is reduced or missing, the basal segment of the inferior appendage is comparatively larger, occupying the space normally filled by segment IX. Parameres are usually absent. The aedeagus is either simple and tubular, or bears membranous portions of varying complexities.

Types of new species and redescribed species are deposited in the collections of Nanjing Agricultural University, P.R. China (NAU, not specifically indicated in the text), or partly in NAU and partly in the Clemson University Arthropod Collection (CUAC).

Goera raghu Group, Schmid 1991

Characters used to establish this Group include the absence of the subventral portion of abdominal segment IX and the articulation of the inferior appendage's distal segment. In this Group, the basal segment of the inferior appendage is usually enlarged and upright, occupying the position normally assumed by sternum IX's subventral portion. Abdominal sternum VI bears one fingerlike process. *Goera clavifera* Schmid from China is a member of this Group. The following new species is proposed for inclusion in this species Group.

Goera bicuspidata Yang and Armitage, New Species
(Figs. 1A–1E)

Description.—Body yellowish brown, forewing testaceous with hairs concolorous, male antennal scape 3 to 3.5 times as long as wide; distal segment of maxillary palp oval, 2 times as long as wide, each with inner lobe covered with dark brown scales; sternite VI bearing one fingerlike process, 3.5 times as long as wide.

Male genitalia (Fig. 1).—Dorsum IX broad in lateral view, and with subventral portion missing. Preanal appendages slender and clavate, with apical taper. Dorsal process of tergum X present, represented by single, slightly clavate lobe. Lower, paired processes of tergum X simple and terete, not sclerotized. Basal segment of each inferior appendage much enlarged, bearing elongate, dorsal spinelike process, and shorter ventral process with apex pointed slightly mesad. Distal segment of inferior appendage completely fused with basal segment, and consisting of elongate dorsal lobe with apex flattened apically as seen in dor-

sal and ventral view; and short, subtending point also pointing slightly mesad. Phallus a simple tube, laterally compressed near apex, with no parameres. Phallic apodeme forming acute angle anteriorly.

Length of forewing.—Male 5–5.2 mm.

Immature stages and female.—Unknown.

Holotype male.—Yunnan Province. Wen-shan-xian, 5 km N of Wen-shan, Sanjiao-tang, 9 July 1990, 1300 m elev., Li Youwen and Ke Xin. Paratype: 15 males (NAU); 5 males (CAUC).

Etymology.—Latin, "two points", with reference to the shape of the inferior appendages viewed ventrally.

Diagnosis.—This species is similar to several species within the *Goera raghu* Group in having inferior appendages each with two distinctive acute processes in ventral view, but differs: (1) in segment IX roughly forming an equilateral triangle in lateral view; (2) in the dorsal process of each inferior appendage with apex flattened apically; and, (3) in the basal segment of each inferior appendage oriented vertically, heightened, about one third as wide as high.

Distribution.—Known only from the type locality in southwestern China.

Unnamed Species Grouping No. 1

A second group of species within the Chinese fauna, similar to the *Goera raghu* Group, is suggested, but awaits a more complete examination of the world *Goera* fauna. This group, like the *G. raghu* Group, lacks the subventral portion of abdominal segment IX and has an enlarged basal segment of each inferior appendage, which occupies the position normally assumed by the subventral portion of sternum IX. In contrast, the long, dorsal, spinelike distal process on the inferior appendage is absent. Sternum VI bears one fingerlike process. Current species from China which exhibit these character states include *G. quadripunctata* Schmid and *G. foliacea* Schmid. The following new species appears related to these species.

Goera spiralis Yang and Armitage, New Species

(Figs. 2A–2E)

Description.—Specimen rather denuded in alcohol, maxillary palpi broken. Body yellowish brown, forewings with trace of yellowish brown hairs. Sternite VI bearing one, very short process, 1.5 times as long as wide.

Male genitalia (Fig. 2).—Dorsum IX reduced in size compared to other species, wider than tall in lateral view, and with subventral portion missing; ventrum IX represented by small triangular patch in ventral view. Preanal appendages slender and clavate. Dorsal process of tergum X present, represented by single, slightly clavate lobe; lower, paired processes of tergum X simple and terete, not highly sclerotized. Basal segment of each inferior appendage much enlarged and semispherical in lateral view; dorsal spinelike process of *G. raghu* Group absent. Distal segment of each inferior appendage consisting of arcuate dorsal process directed ventrolaterad apically and shorter ventral process twisted in relation to former process in ventral view. Phallus simple tube, with no parameres. Phallic apodeme quadrate.

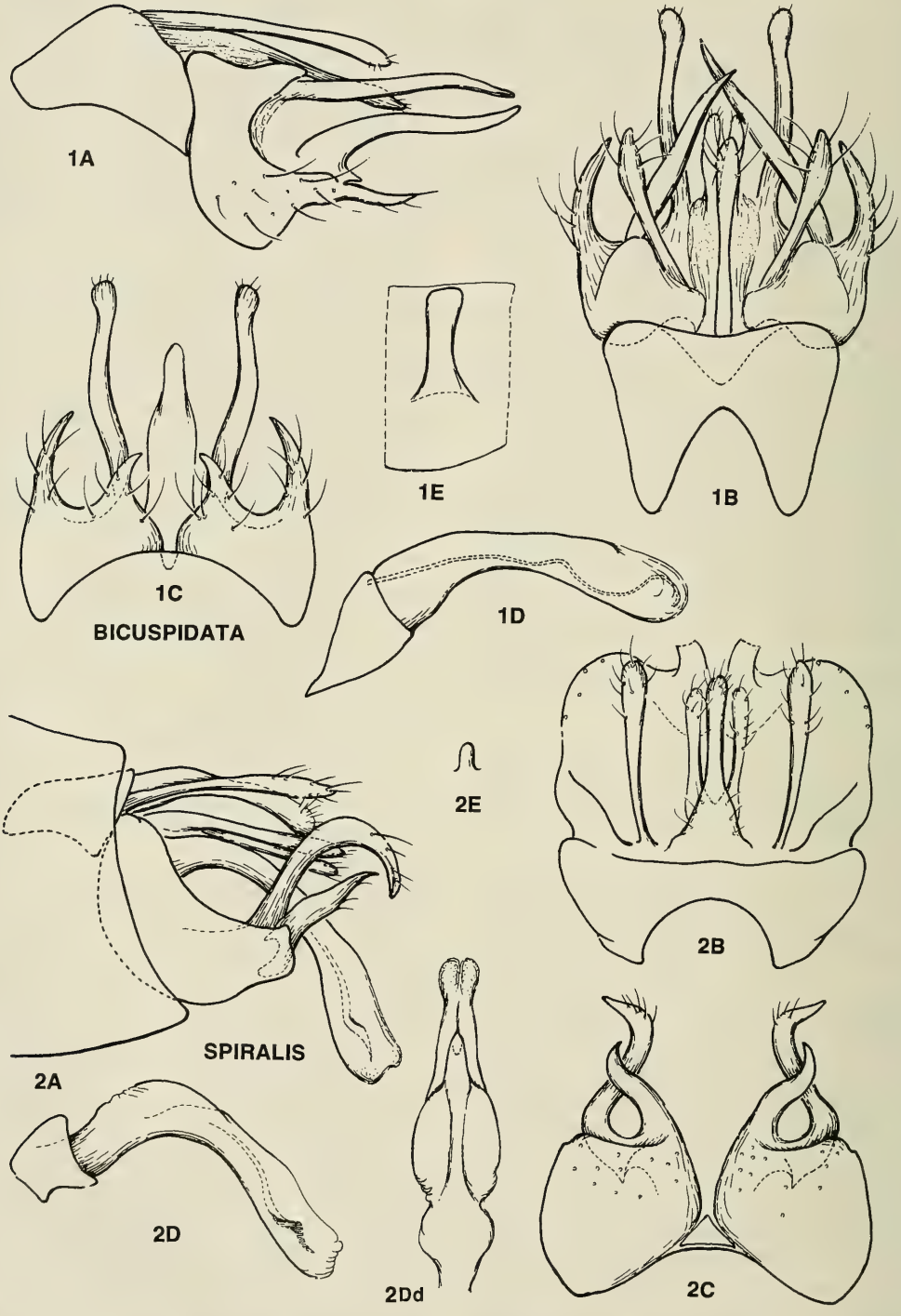
Length of forewing.—Male 5 mm.

Immature stages and female.—Unknown.

Holotype male.—Yunnan Province. Wen-shan-xian, 5 km N of Wen-shan, Sanjiao-tang, 9 July 1990, 1300 m elev., Li Youwen and Ke Xin.

Etymology.—Latin, "a spiral," with reference to the shape of the inferior appendages viewed ventrally.

Diagnosis.—This species is similar to *Goera quadripunctata* Schmid 1959 from Li-jiang, Yunnan Province, in having a very similarly shaped arcuate dorsal process of the distal segment of each inferior appendage, but differs in the lower mesal process of the appendage's distal segment which in this new species is much developed and twisted in relation to the dorsal process in ventral view.



Figs. 1–2. 1, *Goera bicuspidata.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view; D, phallus, left lateral view. Sternite VI: E, ventral view. 2, *G. spiralis.* Male genitalia: A, left lateral view; B, dorsal view; C, phallus, left lateral view; Dd, phallus dorsal view. Sternite VI: E, ventral view.

Distribution.—Known only from the type locality in southwestern China.

Goera minor Group, Malicky and Chantaramongkol 1992

The *Goera minor* Group is defined by the absence of subventral sternum IX and by the long, arcuate process arising from the distal segment of each inferior appendage. Sternite VI bears a single, tonguelike process. No previously described species from China belongs to this group. However, the following new species collected during this study is proposed for inclusion.

Goera arcuata Yang and Armitage, New Species

(Figs. 3A–3E, 18A–18C)

Description.—Body yellow brown. Basal two segments of male maxillary palp dark brown, distal segment elongate oval, with golden yellow hairs; on latter's inner surface, apparent narrow aperture present, possibly to internal sac of non-pigmented scales. Forewings faded in alcohol, sparsely covered with yellowish brown hairs. Sternite VI bearing one finger-like process, 2.5 to 3 times as long as wide.

Male genitalia (Fig. 3).—Dorsum IX appearing as subequilateral triangle in lateral view; subventral portion of abdominal segment IX absent; and, ventral portion of abdominal segment IX present as a broad, subtriangular plate in ventral view. Dorsal process of tergum X clavate, about as long as preanal appendages; ventrolateral processes of abdominal segment X closely appressed to each other, 1.3 times as long as dorsal process. Basal segment of each inferior appendage subrectangular, bearing long, curved, heavily sclerotized spine dorsally; distal segment completely fused with basal segment and represented by an arcuate mesodorsal process with an inflated apex, curved posteroventrad in lateral view, sinuate in dorsal and ventral view. Phallus tube-like; phalicata not distinct.

Female genitalia (Fig. 18).—Preanal appendages fused with tergum X, slightly divergent in dorsal or ventral view; in lateral view, subparallel-sided dorsoventrally, three times as long as high. Lamellae subtruncate with lower lateral portion extremely convex in lateral view, each with apicomesal point slightly produced in ventral view. Gonopod plate broad, subrectangular, 2.5 times as wide as long in ventral view, with median apicomesal lobe two-fifths as long as base. Spermathecal plate generally anchor-shaped, roughly 2.2 times as long as wide.

Length of forewing.—Male, 4 mm; female, 5 mm.

Immature stages.—Unknown.

Holotype male.—Yunnan Province, He-kou-xian, stream 5 km N of Nan-xi-he-zhen, 20 July 1990, 300 m elev., Li You-wen.

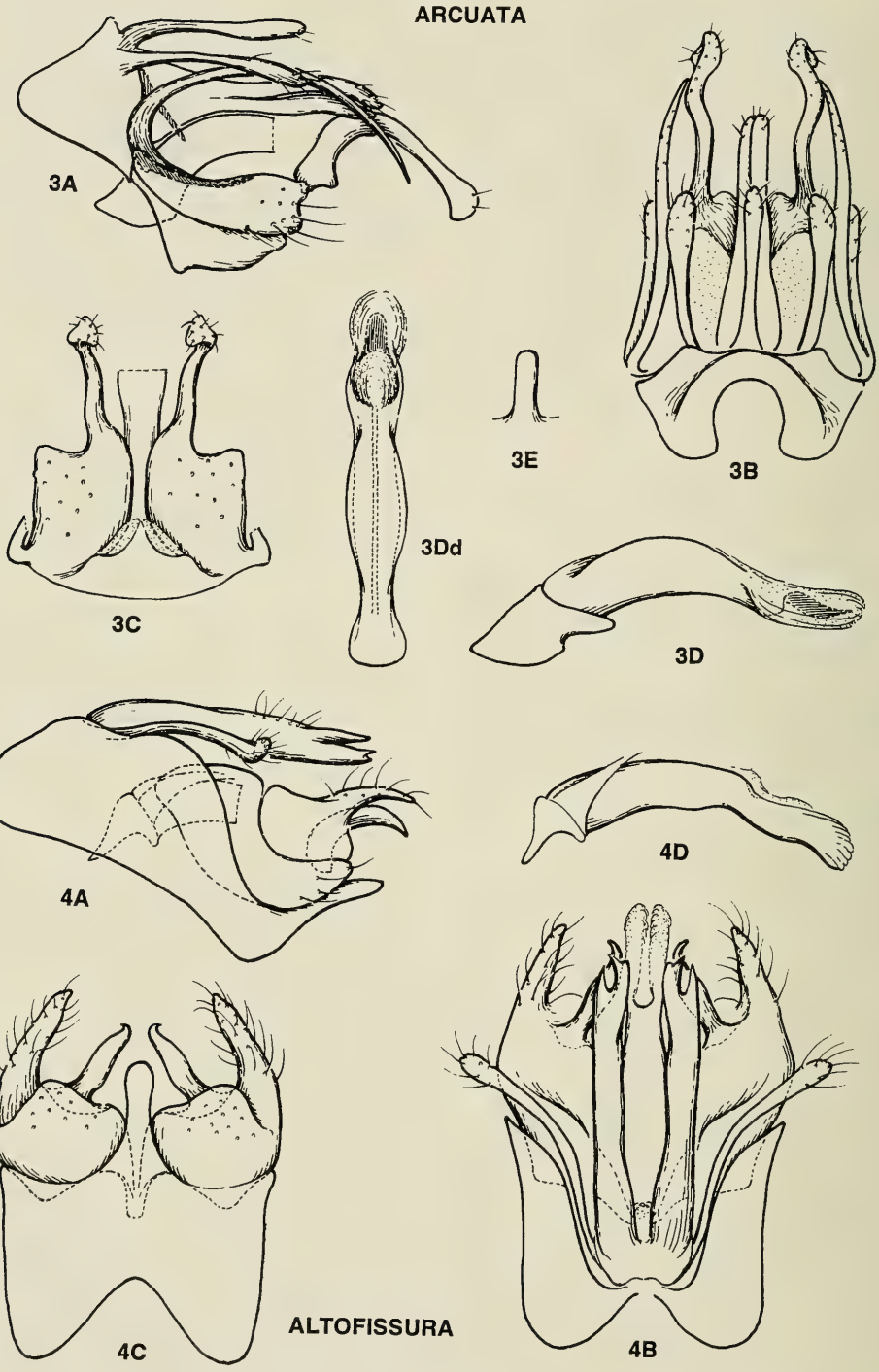
Etymology.—Latin, "an arch"; with reference to the shape of the distal segment of each inferior appendage viewed laterally.

Diagnosis.—This species is very close to *Goera schmidi* Denning in the pattern of male genitalia, but differs from it in having (1) ventrolateral processes of tergum X not completely fused, (2) reduction in the anterior portion of the basal segment of each inferior appendage with corresponding elaboration of the dorsal spine, and (3) more arcuate and capitate second segment of each inferior appendage.

Distribution.—Known only from the type locality in southwestern China.

Goera fissa Group Yang and Armitage, New Group

The members of this group are defined by the elongation of abdominal sternum IX into a simple or bifid lobe, and the absence of tergum X's dorsal process. Sternite VI has a comb-like array of spines. The distal segment of each maxillary palp is usually oval; the opening of the scale-bearing inner lobe appears as a short, longitudinal, narrow aperture bearing pigmented, closely appressed scale-like setae, sometimes arranged as one or two stripes. Current species from China which fall into this group



Figs. 3–4. 3, *Goera arcuata.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view; D, phallus left lateral view. Sternite VI: E, ventral view. 4, *G. altofissura.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view, D, phallus, left lateral view.

include *Goera altofissura* Hwang (= Huang), *G. fissa* Ulmer, *G. latispina* Schmid, and *G. martynowi* Ulmer. A previously described Korean species recorded here for the first time from China, *G. interrogationis* Botoşăneanu, is also a member. Two new species are proposed for inclusion, *Goera ramosa* and *G. redacta.*

Goera altofissura Hwang 1957
(Figs. 4A–4D, 12A–12C)

Goera altofissura Hwang, 1957: 397–398, figs. 112–117; holotype male; type locality = Fujan Province, P.R. China; type depository = P.R. China?, unknown

Goera altofissura was collected from seven localities in four provinces. Males and females were taken at six of the sites. Distal segment of male maxillary palp oval, 2 times as long as wide, its outer surface covered with golden hairs, inner surface bare; opening of scale-bearing inner lobe appearing as short, longitudinal, narrow aperture, bearing darkly pigmented, closely appressed scale-like setae as two dark stripes. Male genitalia have been redrawn (Fig. 4). Sternite IX produced into finger-like process rounded at apex, not quite one half as long as main portion of segment IX. Ventrolateral branches of tergum X sclerotized, stout and straight, each with shallow, apical bifurcations. Preanal appendages divergent, apical portion of each preanal appendage blunt and bent dorsad. Dorsal and mesal processes of each inferior appendage's second segment arcuate, pointed in lateral view, and with mesal process pointed slightly laterad in ventral view.

Female genitalia (Fig. 12).—Preanal appendages fused with tergum X, finger-like, 3 to 3.5 times as long as wide each with rounded apex in lateral view. Lamellae each with distinctive constriction around its middle surface such that each seems to be divided into two lobes in lateral view. Gonopod plate subquadrate with apicomesal lobe broad, about 4 times as wide as its length in ventral view. Spermathecal sclerite simple and viola-shaped in ventral view, constricted at basal one third distance.

Length of forewing.—Male, 8.5 to 9 mm; female, 10 mm.

Immature stages.—Unknown.

Material examined.—Anhui Province. 2 males and 2 females, Dong-zhi-xian, Feng-shui-cun, Qiou-pu-qiao-he, 11 km SE of Dong-zhi, 7 June 1990, 30 m elev., J. C. Morse, Yang Lianfang, and Sun Changhai (CUAC); 1 male, Jiuhua Mt., 5 June 1989, Sun Changhai; 2 males and 2 females, Xi-xian, Yang-jia-tan, Feng-yuan-shui, 24 May 1990, 215 m elev., J. C. Morse and Sun Changhai; 2 males and 3 females, Xi-xian, Shang-feng, 23 June 1991, Sun Changhai and Zhao Lixin. Zhejiang Province. 1 male, 26 June 1986, Yang and Hu. Jiangxi Province. 2 males and 1 female, Yu-shan-xian, San-qing-shan, Shuang-xi-he, 80 km S of Yu-shan, 27–28 May 1990, J.C. Morse and Sun Changhai. Hubei Province. 8 males and 1 female, Ma-cheng-xian, 15 km NE of Ma-cheng, Zheng-shui-he, 1 km S of Gui-shan Tea Farm, 13 July 1990, J. C. Morse and Wang Shida.

Distribution.—Previously known from Fujan Province in southeastern China; now known from six other localities in southeastern China.

***Goera ramosa* Yang and Armitage,**
New Species
(Figs. 5A–5E, 13A–13C)

Description.—Body brown, covered with brown to dark brown hairs. Distal segment of male maxillary palp shaped similar to that of *Goera altofissura,* but inner lobe opening appears only as one dark scale-bearing stripe. Sternite VI bearing comb-like array of spines with middle spine sturdy.

Male genitalia (Fig. 5).—Dorsum IX long in lateral view, with apicomesal process of sternum IX developed into single rounded lobe at least two-thirds as long as main body of segment IX. Preanal appendages slender and clavate. Dorsal process of tergum X absent; ventrolateral processes

highly sclerotized and branched, each process with inner branch bifurcate and with outer branch slightly shorter than inner branch. Basal segment of each inferior appendage about three times as long as tall. Distal segment of each inferior appendage well developed compared to most species, with broad basal portion clearly separated from basal segment, with dorsal portion developed into elongate, flattened lobe, and with separate, mesal sclerotized arm with apex acute and hooked laterad. Phallus simple tube with no parameres. Phallic apodeme forming acute angle anteriorly.

Female genitalia (Fig. 13).—Preanal appendages fused with tergum X, elongate in lateral view, at least 5 times as long as wide. Lamellae distinctively bilobed in both lateral and ventral views. Gonopod plate about 1.5 times as broad as long, apicomesal process 2.5 times as wide as long in ventral view. Spermothecal sclerite simple, with anterior portion broadly rounded.

Length of forewing.—Male, 9.5–10 mm; female, 10–10.5 mm.

Immature stages.—Unknown.

Holotype male.—Sichuan Province. Qing-sheng-shan, 32 km SW of Guan-xian, Wei-jiang-he, 730 m elev., 20 June 1990, J. C. Morse, Yang Lianfang, and Chen Xiaoen. Paratypes, 5 males and 5 females (NAU), 2 males and 1 female (CUAC), same data as holotype; 8 males and 7 females, Du-jiang-yan, 6 km W of Guan-xian, Bai-shui-he, 780 m elev., 18 June 1990, Yang Lianfang and Chen Xiaoen.

Etymology.—Latin, "full of branches", with reference to the branching processes of male tergum X.

Diagnosis.—This species, *Goera altofissura* Hwang (= Huang) and *G. redacta* sp. n. are very closely related in sharing the following homologue: a notched inner apical projection of each lower lateral process of tergum X; the notch is very weak in *G. altofissura,* but very distinctive in this species and *G. redacta.* In male genitalia, *G. ramosa* differs from *G. altofissura* in having deep branching of each lower lateral process of tergum X and from *G. redacta* by the greater length of its lateral branch. The ventral process of sternum IX is broader than that of *G. redacta.* Finally, the interior, mesal process of the inferior appendage's distal segment in ventral view has an acute apex which is hooked laterad. In female genitalia, *G. ramosa* differs from *G. altofissura* in the transversely broad gonopod plate with a relatively smaller apicomesal process and in the spermathecal sclerite without constriction near its base; it differs from *G. redacta* in having elongate lateral lobes on tergum X; and it differs from both of these related species by its conspicuous bilobed lamellae.

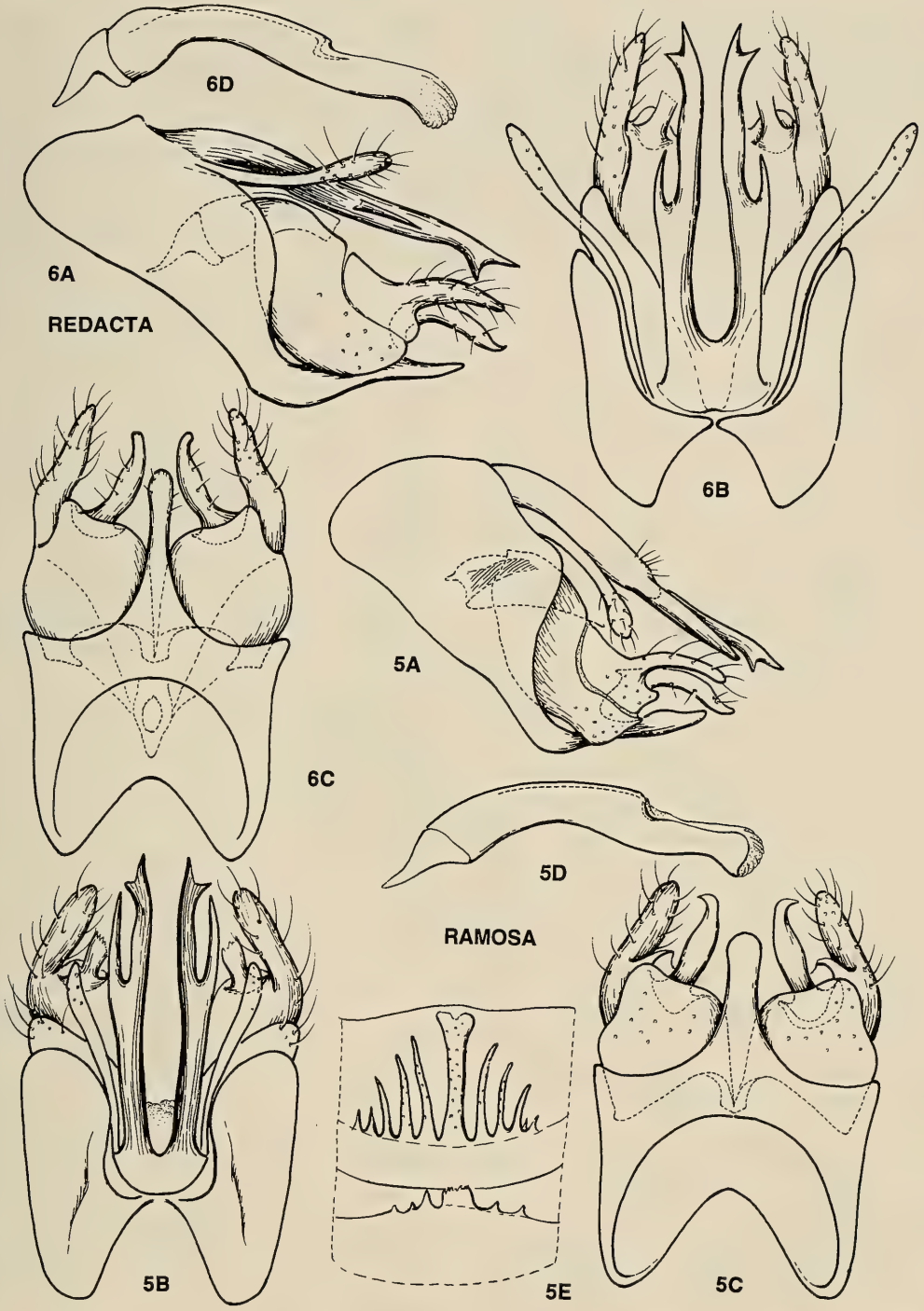
Distribution.—Known only from type series in southwestern China.

Goera redacta Yang and Armitage, New Species
(Figs. 6A–6E, 14A–14C)

Description.—Body brown, forewings covered with golden brown hairs. Maxillary palps similar in structure and appearance to those of *Goera ramosa.* Sternite VI bearing comb-like array of spines with middle spine sturdy.

Male genitalia (Fig. 6).—Dorsum IX, apicomesal process of sternum IX, and preanal appendages similar to those of *Goera ramosa.* Dorsal process of tergum X absent; ventrolateral, paired processes of tergum X highly sclerotized and branched; each with inner branch deeply notched at apex, forming two acute apical spines; outer branch much shorter than inner branch, and arising from midpoint of process. Basal segment of each inferior appendage one half as long as high. Distal segment of each inferior appendage similar to that of *G. ramosa,* with broad basal portion clearly separated from basal segment and developed dorsally into an elongate, flattened lobe, interior, mesal sclerotized arm with apex acute and hooked dorsad. Phallus simple tube with no parameres. Phallic apodeme forming acute angle anteriorly.

Female genitalia (Fig. 14).—Preanal ap-



Figs. 5–6. 5, *Goera ramosa.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view; D, phallus, left lateral view. Sternite VI: E, ventral view. 6, *G. redacta.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view, D, phallus, left lateral view.

pendages fused with tergum X, each triangular, about 1.6 to 1.7 times as long as wide basally in dorsal view; laterally appearing elongate, with subapical ventral swelling. Gonopod plate subrectangular, similar to that of *Goera ramosa.* Spermathecal sclerite simple, with anterior portion broadened, without distinctive constriction near its base.

Length of forewing.—Male, 9.7 mm; female, 8.8–9.8 mm.

Immature stages.—Unknown.

Holotype male.—Sichuan Province. E-mei-shan, 3 km W of Jing-shui, E-mei-he, 910 m elev., 1 July 1990, Li Youwen and Chen Xiaoen. Paratype, 1 male and 3 females (NAU), 1 male and 1 female (CUAC), same data as holotype.

Etymology.—Latin, "reduced", with reference to the short, outer branch of tergum X.

Diagnosis.—As discussed above, this species is possibly a sister species to *Goera ramosa,* both species having similar lateral processes of tergum X, with the outer branch arising mesally; and, in the female, having subrectangular gonopod plates and unconstricted spermathecal sclerites. The male of this species differs from that of *G. ramosa* by the relative shortness of its outer branch on each lower lateral process of tergum X, by the narrower ventral process of sternum IX, and by the blunt apex on the mesal process of each inferior appendage's distal segment.

Distribution.—Known only from type locality, southwest China.

Goera interrogationis Botoşăneanu 1970
(Figs. 7A–7E, 15A–15C)

Goera interrogationis Botoşăneanu, 1970: 306–307, plate XXXI; holotype = male; type locality = Korea; type depository = Zoological Institute of the Polish Academy of Sciences (Warsaw).

Goera interrogationis was collected from two localities in two northeastern Chinese provinces. Previously it had only been reported from North Korea. Male antennal scape 3.5 times as long as wide and distal segment of each maxillary palp oval, 1.7 times as long as wide. The male genitalia are redescribed and redrawn here and the female genitalia described for the first time.

Male genitalia (Fig. 7).—Segment IX long, oblique; sternite IX produced into elongate process tapering to an acute point in lateral view, at least two-thirds as long as main body of segment IX, and expanding to flat, truncate lobe in ventral view. Ventrolateral branches of tergum X unbranched, each tapering to acute point, and slightly arcuate in lateral view. Inferior appendage's basal segment very elongate and oblique; distal segment distinct from basal segment and bearing arcuate dorsal process with rounded apex, short ventral lobe, and arcuate mesal process with tapering apices directed laterad in ventral view. Phallus regular, tube-like with phalicata membranous, bearing many tiny spines.

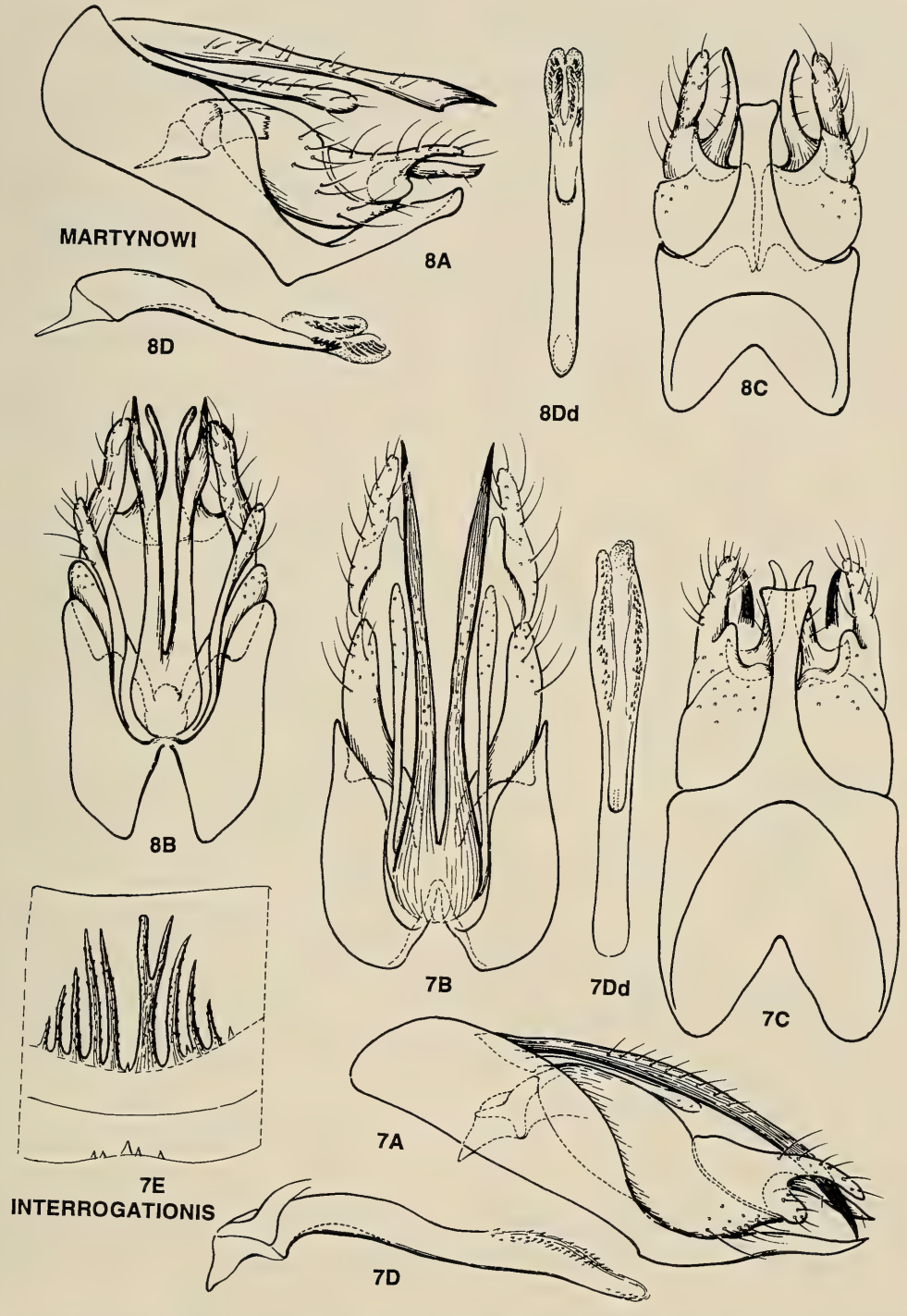
Female genitalia (Fig. 15).—Preanal appendages fused with tergum X, stout and digitate in dorsal view, elongate in lateral view. Lamellae distinctively bilobed with upper lobe short, subtruncate in lateral view. In ventral view, gonopod plate about as long as wide with broadly rounded lateral edges; apicomesal process large, triangular, with blunt apex. Spermathecal sclerite subrectangular, about 2.2 times as long as wide, with paired anteromesal longitudinal lips, and bearing broad plate anteriorly in ventral view.

Material examined.—Hei-long-jiang Province. 2 males and 1 female, Wu-da-lian-chi, 8 August 1987, Xue Yingen. Ji-lin Province. 1 male, Chang-bai Mt., 980 m elev., 15 August 1983, Zhang Manfu.

Distribution.—Previously known from North Korea; now found in northeastern China.

Goera martynowi Ulmer 1932
(Figs. 8A–8E, 16A–16C)

Goera martynowi Ulmer, 1932: 69–70, figs. 44–45; holotype = male; type locality =



Figs. 7–8. 7, *Goera interrogationis.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view; D, phallus, left lateral view. Dd, phallus, dorsal view. Sternite VI: E, ventral view. 8, *G. martynowi.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view, D, phallus, left lateral view; Dd, phallus, dorsal view. Sternite VI: E, ventral view.

Beijing, P.R. China; type depository = Ulmer collection (Hamburg?) and the Deutsche Entomologische Institut (Eberswalde).

Goera martynowi Ulmer was collected from eight localities in five provinces. Both males and females were taken at six of the sites. Male antennal scape 4 times as long as wide, and distal segment of each maxillary palp short, oval, 1.7 times as long as wide, similar to that of *G. interrogationis.*

The male genitalia have been redrawn (Fig. 8) and the female described. This species is very similar to *Goera interrogationis* in the shape of sternite IX in ventral view, of the ventrolateral branches of tergum X, of the inferior appendage's distal processes, and of the structure of the phallus. It differs from this species in the smaller basal segment of the inferior appendage, only about 2 times as long as high; in the approximate 90 degree angle formed by sternite IX and its ventral extension rather than the approximate 120 degree angle in *G. interrogationis*; and, in the apex of each lower lateral process of tergum X, usually very thick with an inconspicuous notch in lateral view.

Female genitalia (Fig. 16).—Preanal appendages fused with tergum X, each triangular, 1.5 times as long as wide basally in dorsal view; laterally appear slightly sinuate and pointed. Lamellae not conspicuously bilobed. Gonopod plate gradually tapering with short, broad apicomesal process. Spermathecal sclerite smaller than that of *Goera interrogationis,* anteriorly bearing triangular plate in ventral view.

Material examined.—Anhui Province. 1 male and 1 female, Jiu-hjua-he, 5 June 1989, Sun Changhai; 3 males and 1 female, Lang-xi-xian, Yao-cun, Young-fen-he, 23 May 1990, J. C. Morse, Yang Lianfang, and Sun Changhai; 8 males and 4 females, Dong-zhi-xian, Feng-shui-cun, Qiou-pu-qiao-he, 11 km SE of Dong-zhi, 7 June 1990, 30 m elev., J. C. Morse and Yang Lianfang. Hubei Province. 1 male and 2 females, Ma-cheng-xian, 15 km NE of Ma-cheng, Zheng-shui-he, 1 km S of Gui-shan Tea Farm, 13 July 1990, 250 m elev., J. C. Morse and Yang Lianfang. Jiangsu Province. 2 males, Nanjing, 21 June 1989, Chu Xuping. Jiangxi Province. 1 male, Yu-shan-xian, San-qing-shan, Shuang-xi-he, 80 km S of Yu-shan, 27–28 May 1990, 470 m elev., J. C. Morse and Yang Lianfang. Sichuan Province. 1 male and 1 female, Xin-jin-xian, 4 km N of Xin-jin, 550 m elev., 18 June 1990, J. C. Morse and Li Youwen. Zhejiang Province. 2 males, Tian-mu-shan, 26 June 1985, J. C. Morse and Sun Changhai.

Distribution.—Type locality in northern China; now found in southeastern and southwestern China.

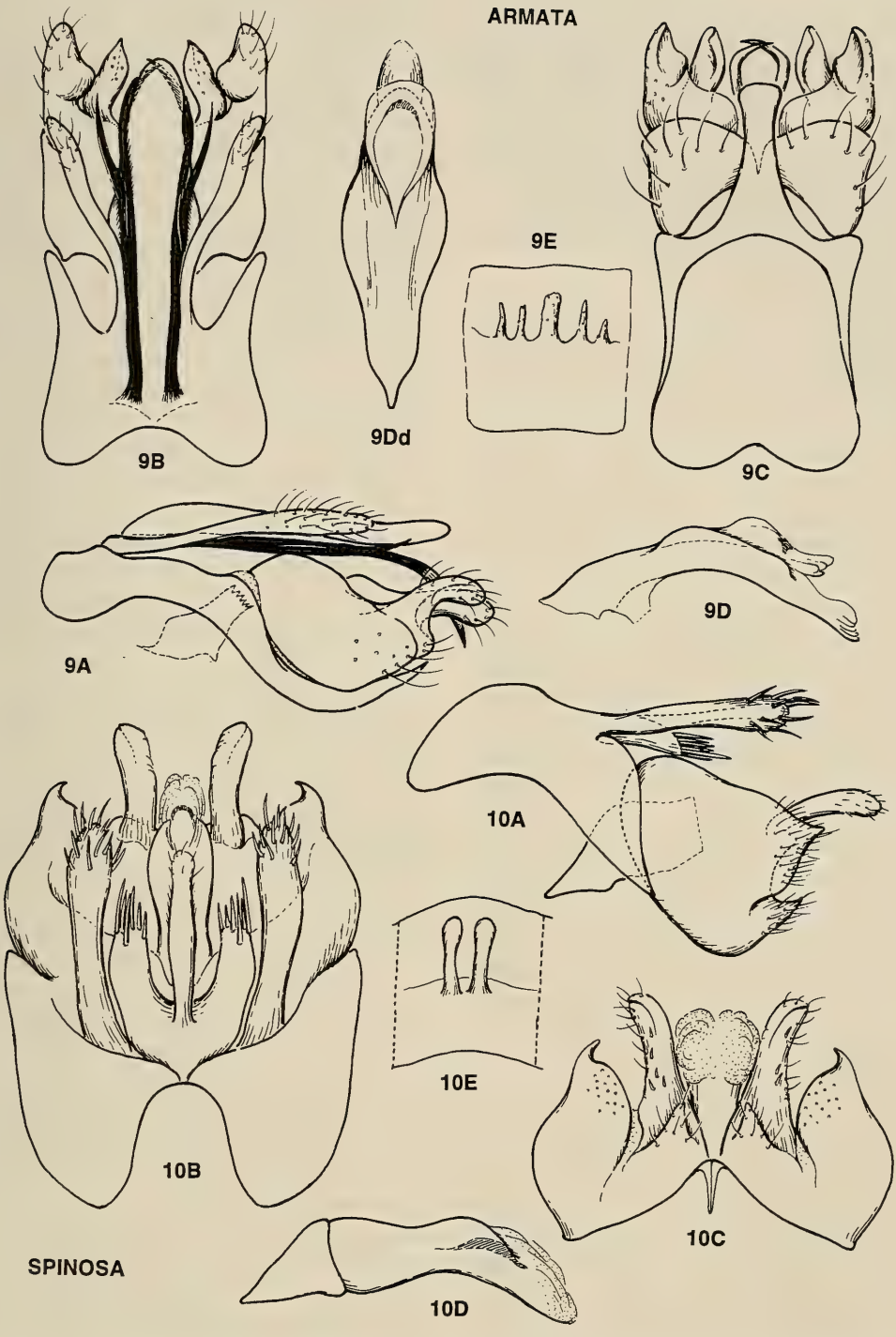
Unnamed Species Grouping No. 2

Another suggested grouping of species bears resemblance to *Goera fuscula* Banks and related eastern North American species. Members of this group are characterized by the presence of an elongate, median dorsal process in tergum X, the oblique orientation of segment IX, and the ventral position of each inferior appendage's distal segment. Species from the Oriental Region have sternite IX produced ventrally into an elongate process, as in the *G. fissa* Group. Species from the Nearctic demonstrate a reduction in this process's length. Sternite VI has a comb-like array of spines. Species in this group which occur in China include *G. armata* Navás, *G. crassata* Schmid, and *G. tecta* Schmid. *Goera armata* is herein redescribed and its genitalia redrawn.

Goera armata Navás 1933
(Figs. 9A–9E)

Goera armata Navás, 1933: 21, fig. 36: a, b. holotype = male, type locality—Chusan (Zhou-shan), Zhejiang Province; type depository = Zoological Institute, Academia Sinica, Beijing.

The senior author was able to see the type specimen, but was not allowed to clear the genitalia. Navás's figure for the male genitalia of this species was rather simple.



Figs. 9–10. 9, *Goera armata.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view; D, phallus, left lateral view. Dd, phallus, dorsal view. Sternite VI: E, ventral view. 10, *G. spinosa.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view, D, phallus, left lateral view. Sternite VI: E, ventral view.

Our single specimen from Anhui, southeast China, appears to agree reasonably well with it, and on the limited material available is placed as *G. armata.*

Description.—Body dark brown, forewings brown with dark brown hairs. Sternite VI bearing short transverse array of spines with middle spines fused, 2.5 times as long as wide.

Male genitalia (Fig. 9).—Dorsum and sternum IX very narrow and segment oblique in lateral view, with the apicomesal process of sternum IX developed into tonguelike lobe. Preanal appendages slender and clavate. Dorsal median process of tergum X produced as single, large lobe, dorsoventrally flattened. Lower lateral processes of tergum X highly sclerotized and branched from their midpoint, with inner branch apex arcuate and mesoventrally directed, and outer branch shorter with the apex pointed slightly dorsad. Basal segment of each inferior appendage bearing no processes; distal segment consisting of dorsolateral process arcuate and blunt with concave mesal face and dorsomesal lobe, and of ventromesal process, slightly concave laterally, elongate, apically rounded in lateral view, but produced into point in dorsal view. Phallus with longitudinal lateral flanges large, produced laterally in dorsal view. Phalicata as membranous lobe emerging from dorsum of phallus about midway along its length. Phallic apodeme forming an acute angle anteriorly.

Length of forewing.—Male, 9 mm.

Immature stages.—Unknown.

Material examined.—Anhui Province, 1 male, Xi-xian, Yian-yuan-xiang, Huangbuo-shan, 21 April 1991, Sun Changhai.

Diagnosis.—The male of this species is most similar to that of *Goera tecta* Schmid, by the presence of the median dorsal process of tergum X, by each of the lower mesal processes of tergum X branched from its midpoint, by the dorsal and mesal processes of each inferior appendage's distal segment, and by the phallus with its large dorsal flange expanded laterad. This species differs by the shape of the median dorsal process of tergum X in dorsal view and by the longer inner branch of each lower lateral process of tergum X.

Distribution.—Previously known from Chusan, Zhejiang Province in southeastern China; now found at another locality in the southeastern region, 375 km W of Chusan.

Unnamed Species Grouping No. 3

The following new species from mainland China bears little resemblance to any other species of *Goera* in China, or elsewhere. This species bears two fingerlike processes on sternum VI and apical spines on the preanal appendages and on the lateral lobes of tergum X. In addition, the inferior appendages are reduced in structure and complexity. Phylogenetic association of this species with others in the genus will have to await a future analysis of all *Goera* species.

Goera spinosa Yang and Armitage, New Species

(Figs. 10A–10E, 17A–17C)

Description.—Specimens teneral, body yellowish brown, wings pale, distal segment of each maxillary palp slender, 4 to 4.5 times as long as wide with short basal lobe. Sternite VI bearing two, fingerlike processes, each 4 times as long as wide.

Male genitalia (Fig. 10).—Segment IX broad dorsally, with subventral portion missing. Preanal appendages thick and clavate with the apical portion bearing stout setae. The dorsal process of tergum X is represented by a single, clavate lobe; lower, paired lateral processes of tergum X thick, about half as long as dorsal process and bearing heavy setae apically. Basal segment of each inferior appendage enlarged, bearing no processes, and produced posteriorly into slightly mesad-directed point. Distal segment of each inferior appendage consisting of mesal process bearing small spines on ventral surface and ventral, triangular lobe. Phallus short and tubular with membranous apex and with no parameres.

Phallic apodeme forming acute angle apically.

Female genitalia (Fig. 17).—Preanal appendages fused with tergum X and mostly with each other, subrectangular in lateral view, roughly 1.6 times as long as wide. Supragenital plate ovate, extending nearly to apical margin of tergum X. Lamellae appears short and blunt with posterior margin slightly sinuate. In ventral view, posterior margin of gonopod plate deeply concave submesally, apicomesal portion produced in triangular lobe with a pair of clasper receptacles just beneath it. Spermathecal sclerite simple, heart-shaped.

Length of forewing.—Male, 6.3 mm; female, 7.2 mm.

Immature stages.—Unknown.

Holotype male.—Anhui Province. Xixian, Yan-yuan-Xiang, Huang-bai Mt., 21 April 1991, Sun Changhai. Paratype, 4 females, same data as holotype.

Etymology.—Latin, "many spines," with reference to the peculiar thick spines found on the preanal appendages and lower lateral processes of tergum X.

Diagnosis.—This species is not close to any other species assigned to this genus. It differs in the two club-like processes of sternum VI, in the spiniferous apices of the preanal appendages and of the lower lateral processes of tergum X, and in the morphology of the inferior appendages.

Distribution.—Known only from the type locality in southeastern China.

Unnamed Species Grouping No. 4

The grouping of *Goera paramika* Schmid, *G. paramahansa* Schmid and *G. parabhava* Schmid was suggested by Schmid (1991) when he described them. Members of this group are defined by the elongate dorsal and inner processes of each inferior appendage's second segment. The ventrolateral paired processes of tergum X are each broad at the base, tapering to an acute apex. Sternite VI bears a single, tonguelike process. No previously described species from China belong to this group. However, the following new species appears to be related. We have deferred, as did Schmid, from formally creating a species group to include these taxa until a more thorough examination of the genus is made.

Goera morsei Yang and Armitage, New Species
(Figs. 11A–11E, 19A–19C)

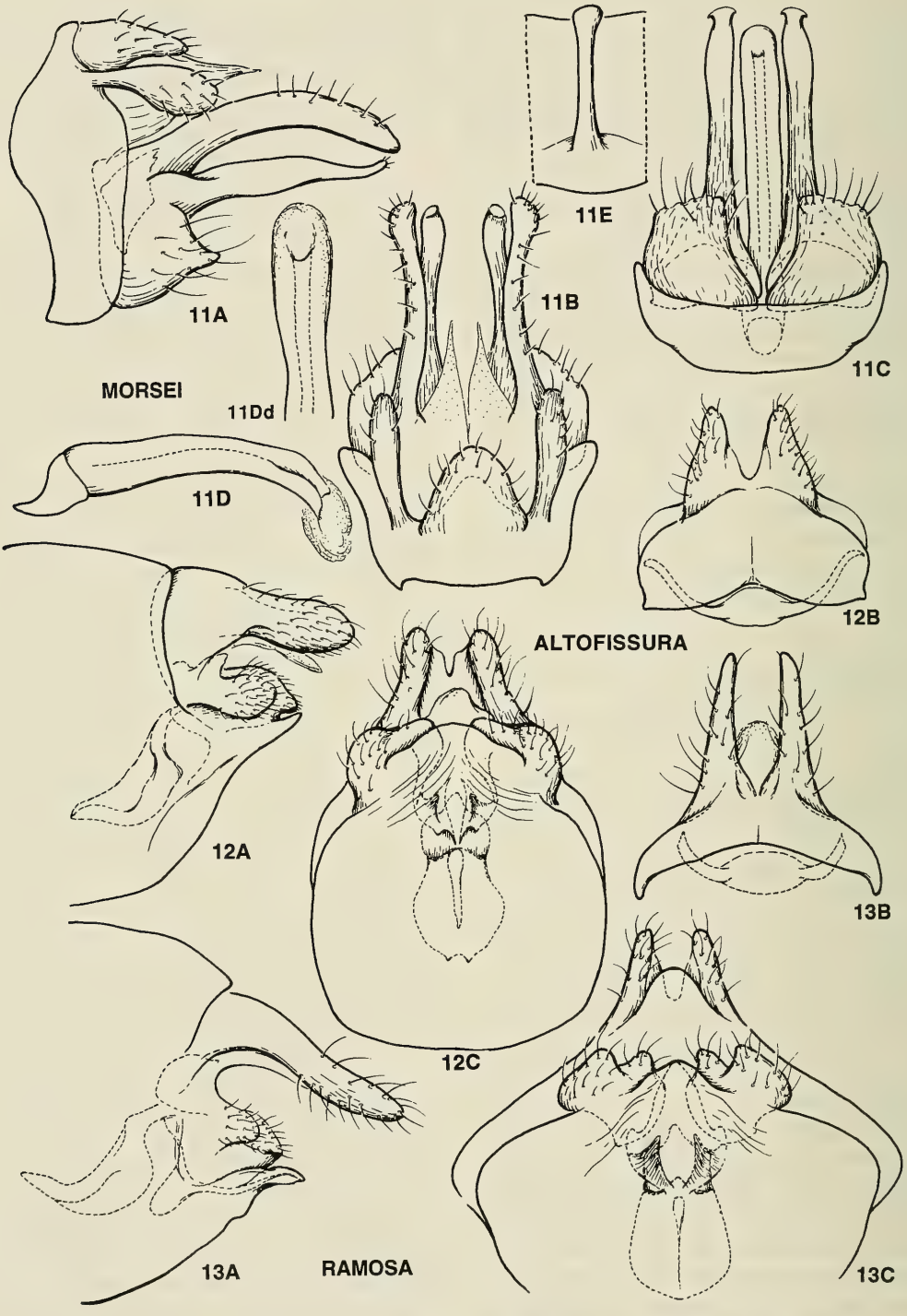
Description.—Body yellow brown. Maxillary palp covered with golden hairs; each with distal segment elliptical, 3 to 3.5 times as long as wide, with golden brown scales on its inner lobe. Ventral process of abdominal segment VI single, 6 to 7 times as long as wide.

Male genitalia (Fig. 11).—Segment IX complete, posterior margin below preanal appendages straight in lateral view. Tergum X with dorsal process a short, broad lobe, as long as wide and slightly swollen; ventral portion semi-membranous, deeply divided, each portion broad at base and tapering to acute apex. Ventroposterior margin of basal segment of each inferior appendage angulate in lateral view; distal segment with cylindrical, slightly arcuate dorsal process and somewhat flattened ventral process, curved slightly dorsad. Phallus of typical tube-like form with ejaculatory duct very discernible. Phallic apodeme tapering anteriorly with dorsal constriction.

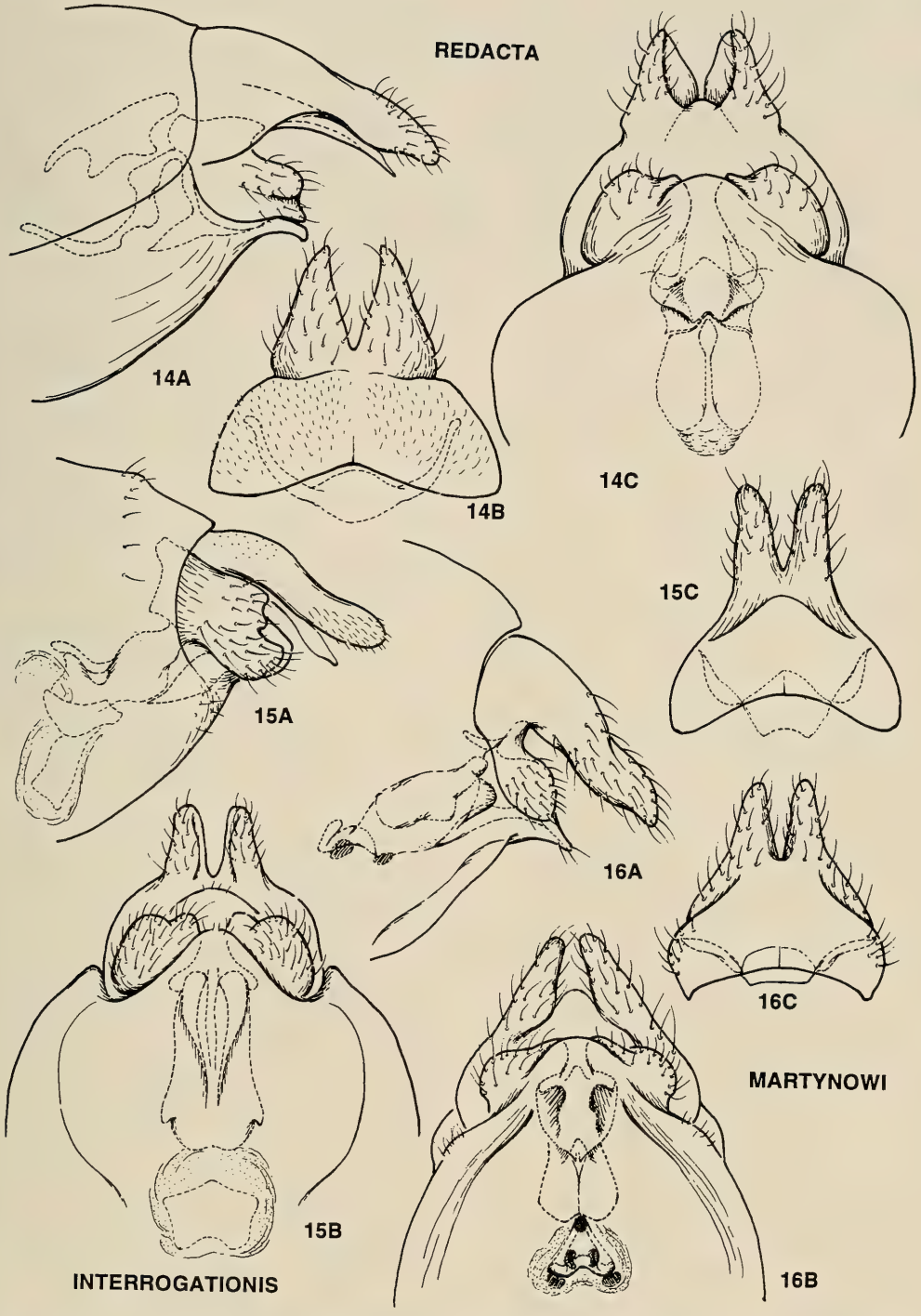
Female genitalia (Fig. 19).—Tergum IX large, triangular, clearly delimited from tergum X. Preanal appendages fused with tergum X and basally with each other. Preanal appendages and tergum X large in lateral view. Lamellae large, each about as long as broad in lateral view, with inner surface concave. Gonopod plate broad with each lateral margin produced into rounded, triangular lobe, and with apicomesal process tapering to enlarged, oval tip in ventral view. Spermathecal sclerite oval, about 1.3 times as long as wide with anterior end abruptly narrowed.

Length of forewing.—Male, 7 mm; female, 8 mm.

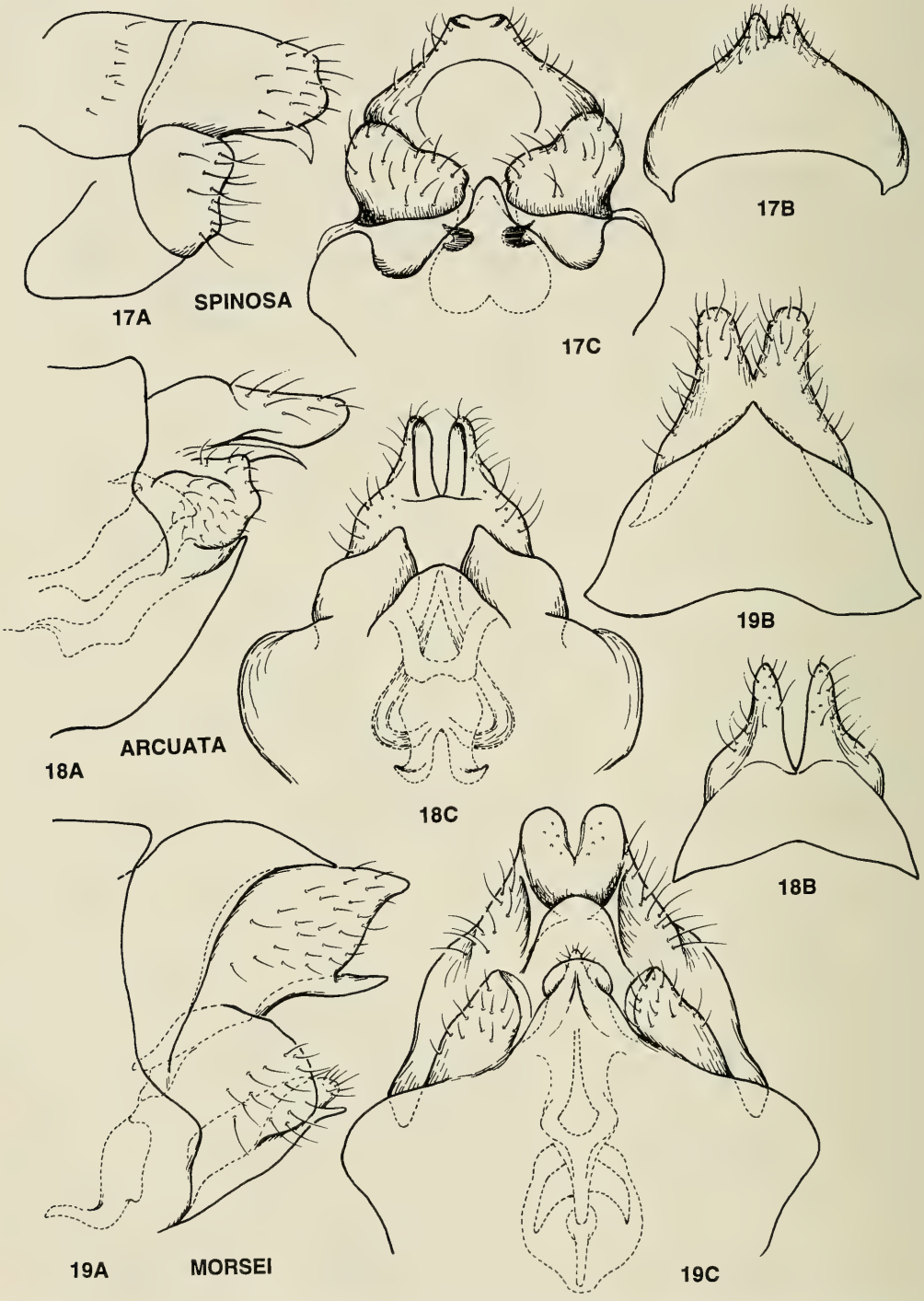
Immature stages.—Unknown.



Figs. 11–13. 11, *Goera morsei.* Male genitalia: A, left lateral view; B, dorsal view; C, ventral view; D, phallus, left lateral view. Dd, phallus, dorsal view. Sternite VI: E, ventral view. 12, *G. altofissura.* Female genitalia: A, left lateral view; B, dorsal view; C, ventral view. 13, *G. ramosa.* Female genitalia: A, left lateral view; B, dorsal view; C, ventral view.



Figs. 14–16. 14, *Goera redacta.* Female genitalia: A, left lateral view; B, dorsal view; C, ventral view. 15, *G. interrogationis.* Female genitalia: A, left lateral view; B, dorsal view; C, ventral view. 16, *G. martynowi.* Female genitalia: A, left lateral view; B, dorsal view; C, ventral view.



Figs. 17–19. 17, *Goera spinosa.* Female genitalia: A, left lateral view; B, dorsal view; C, ventral view. 18, *G. arcuata.* Female genitalia: A, left lateral view; B, dorsal view; C, ventral view. 19, *G. morsei.* Female genitalia: A, left lateral view; B, dorsal view; C, ventral view.

Holotype male.—Sichuan Province. Jiang-you, 2 km NW of Jiang-you, Rang-shui-he (tributary of Fu-jiang), 28 June 1990, 600 m elev., J. C. Morse, Yang Lian-fang, Y. Li, and X. Chen. Paratype: 6 males and 5 females (NAU); 2 males and 2 females (CUAC), same data as holotype.

Etymology.—This species is named in honor of Dr. John C. Morse in recognition of his contributions to the study of aquatic insects in general, and caddisflies in particular, in China.

Diagnosis.—This species is very similar to *Goera kawamotonis* Kobayashi (1987) from Japan. The male of the new species differs (1) in the posterior margin of segment IX not produced into a broad lobe in lateral view, (2) in having the apicoventral margin of each inferior appendage strongly angulate, and (3) in having the dorsal process of the distal segment of each inferior appendage gently curved, rather than with distal half strongly curved downward as in *G. kawamotonis.*

Distribution.—Known only from the type locality in southwestern China.

Acknowledgments

Our sincere thanks to Dr. J. C. Morse for his efforts during the 1990's exploration of southeast and southwest China, for his many useful suggestions concerning species groups in this genus, and for kindly reviewing this paper. Dr. Morse has been instrumental in nurturing and promoting the study of aquatic insects in China through his visits, his training of Chinese graduate students, and his research and publications. We would also like to thank the reviewers for their constructive comments.

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NEW SPECIES AND HOST RECORDS OF APHID PARASITOIDS (HYMENOPTERA: BRACONIDAE: APHIDIINAE) FROM THE PACIFIC NORTHWEST, U.S.A.

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Abstract.—The aphidiine parasitoids (Hymenoptera: Braconidae: Aphidiinae) of the Pacific Northwest, U.S.A., were surveyed. Findings are based principally on field collections from Washington, but a few records from nearby states are included. Twelve genera and more than 40 species are recorded. The material was obtained from pest and nonpest aphid rearings sampled from a range of farmland and neighboring environments. Complete records are provided on the parasitoid species, associated aphid and plant hosts. Four new species of aphidiine parasitoids are described and illustrated: ***Binodoxys clydesmithi*** Pike and Starý, n. sp. (hosts: *Zyxaphis* sp. and *Obtusicauda coweni* Hunter on sagebrush, *Artemisia tridentata*), ***Binodoxys grafi*** Pike and Starý, n. sp. (hosts: *Aphis helianthi* Monell, *Aphis* nr. *varians* Patch, and *Aphis* sp. on *Epilobium angustifolium*), ***Pauesia pseudotsugae*** Pike and Starý, n. sp. (host: *Cinara pseudotaxifoliae* Palmer on *Pseudotsuga menziesii*), and ***Trioxys rosae*** Pike and Starý, n. sp. (host: *Macrosiphum rosae* (L.) on *Rosa* sp.). Also, *Trioxys cirsii* (Curtis), a European species, was detected for the first time in North America (host: *Drepanosiphum platanoides* (Schrank) on *Acer pseudoplatanus*).

Key Words: Parasitoids, new species, *Binodoxys, Pauesia, Trioxys,* aphids

Research on aphidiine parasitoids (Hymenoptera, Braconidae, Aphidiinae) began in Washington in 1989 in association with studies on the biological control of Russian wheat aphid, *Diuraphis noxia* (Kurdjumov). Discovery of new species of parasitoids attacking grain aphids (Pike and Starý 1995b) demonstrated a lack of knowledge concerning the aphid parasitoid species richness and activity within the region, and prompted expanded environmental studies to explore and define the diversity and host range of the aphid parasitoids across a range of farmlands and neighboring ecosystems. The success or extent of parasitoid activity on pest aphids is linked in part to their alternate hosts. The present work represents the first comprehensive review of the known aphidiine parasitoids (Hymenoptera: Braconidae: Aphidiinae) of the Pacific Northwest, U.S.A. region, and provides a basis for further work on such topics as species richness, abundance, spatial and temporal distributions, host-habitat preference,

nature conservation, and ecological optimizations for parasitoid enhancement. The work also provides a basis for comparison of indigenous fauna with new or future introductions.

The review is based on extensive field survey and collections made over 6 years (1989–94). Collections were taken mainly from Washington, but some were taken from nearby states. New descriptions are given for four new species of aphidiine parasitoids reared from aphids on Douglas fir (*Pseudotsuga menziesii*), fireweed (*Epilobium angustifolium*), rose (*Rosa* sp.), and sagebrush (*Artemisia tridentata*).

For cross reference and other information on aphid parasitoids of North America, see Liu 1977, Marsh 1979, and Johnson 1987; for world information, see Mackauer and Starý 1967.

Material and Methods

A search for aphid parasitoids was undertaken by sampling aphids in the field from wild and cultivated plants across a wide range of habitats, i.e. annual and perennial crops, grass and sage rangelands, roadsides, wetlands, wildlife reserves, parks, backyards, gardens, and forest lands. A total of 668 samples was taken during the collection years. Collected aphids were held in semi-transparent plastic containers (300 ml, 10 cm dia × 4 cm ht) on clipped foliage at ambient laboratory temperatures ranging from 17 to 23°C for 30 days to allow for parasitoid development and emergence. Aphidiine parasitoids generally emerged within the first 10 days.

Descriptions of new taxa were based on whole dry and dissected slide-mounted material examined under the microscope at 40 to 600×. Body lengths were measured and recorded in millimeters. Holotypes were dry-mounted on paper tabs and pinned. The descriptive terminology used is after Huber and Sharkey (1993). Holotypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM).

Results

Aphidiine Parasitoid Genera and Species

Parasitoid genera and species are listed alphabetically, as are aphid hosts under each species. References, if any, are listed at the end of each record of aphid host, location, and date of collection. All aphids and parasitoids were collected by the authors unless otherwise indicated. Numbers in parentheses represent authors' codes of specimens (aphid-parasitoids) in Washington State University (WSU)-Prosser collections.

Genus *Adialytus* Förster

A. ambiguus (Haliday)

Sipha elegans del Guercio: MT, Sanders Co., Plains, 26-VII-94, on *Agropyron intermedium* (94R036).

Sipha sp.: WA, Asotin Co., near Anatone, 23-IX-93, on Gramineae (93T022).

A. fuscicornis (Ashmead)

Aphid undetermined: WA, Asotin Co., 8-VII-93, on *Populus trichocarpa* (93T001).

A. salicaphis (Fitch)

Chaitophorus populicola Thomas: ID, Boundary Co., near Bonners Ferry, 26-VIII-94, on *Populus trichocarpa* (94R026).

Chaitophorus utahensis (Knowlton): WA, Yakima Co., Grandview, 3-VI-94, on *Salix* sp. (94-052).

Chaitophorus sp.: WA, Asotin Co., 8-VII-93, on *Salix* sp. (93T002, 93T003). WA, Benton Co., County Line Rd, 20-X-94, on *Salix* sp. (94G088).

Periphyllus sp.: WA, Asotin Co., near Anatone, 25-VIII-93, on *Acer* sp. (93T017).

Genus *Aphidius* Nees

A. avenaphis (Fitch)

Sitobion avenae (F.): WA, Klickitat Co., Bickleton, 16-VI-93, 23-VII-93, on

Hordeum vulgare var. Steptoe (93K002, 93K003), and on *Triticosecale rimpani* (93K001).

A. colemani Viereck

Undetermined aphid: WA, King Co., Seattle, Volunteer Park, V-94, on *Hibiscus* sp. (94T001).

A. ervi Haliday

Acyrthosiphon pisum (Harris): MT, Sanders Co., Plains, 26-VII-94, on *Lathyrus odoratus* (94R034). WA, Benton Co., WSU-Prosser, 17 & 25-V-94, 29-VII-94, on *Medicago sativa* (94-004, 94-010, 94-014, 94-032, 94-037, 94R051), and 17-V-94, on *Trifolium pratense* (94-007).

Brevicoryne brassicae (L.): WA, Benton Co., WSU-Prosser, 1-XI-94, on *Brassica napus* (94G096).

Diuraphis noxia (Kurdjumov): WA, Asotin Co., near Anatone, 5-VIII-93, on *Avena fatua* (93T024). WA, Benton Co., WSU-Prosser, 17-V-94, 2-VI-94, on *Hordeum vulgare* (94-011, 94-050), and 23-IV-91, 27-V-94, 13 & 28-VI-94, on *Triticum aestivum* (91A004, 91A006, 91A008, 94-045, 94-145, 94A008). WA, Yakima Co., Grandview, 29-V-94, on *Triticum aestivum* (94-047).

Rhopalosiphum padi (L.): WA, Benton Co., WSU-Prosser, 17-IV-92, on *Triticum aestivum* (92A006).

Sitobion avenae (F.): WA, Asotin Co., near Anatone, 12-VII-94, on *Triticum aestivum* (94T023). WA, Benton Co., WSU-Prosser, 27-V-94 on *Hordeum vulgare* (94-043), and 27-V-94, 27-VI-94 on *Triticum aestivum* (94-045, 94K098). WA, Whitman Co., near Pullman, 19-VII-93 on *Triticum aestivum* (93T012).

Mixed aphids on cereals: *Diuraphis noxia* (Kurdjumov), *Rhopalosiphum padi* (L.), *Sitobion avenae* (F.), WA, Klickitat Co., near Bickleton, 23-VI-93 on *Hordeum vulgare* (93K004), on *Triticum aestivum* (93K005), and 2-VIII-93 on *Triticosecale rimpani* (93K008).

Undetermined aphid: WA, Asotin Co., near Anatone, 5-VIII-93 on *Lactuca serriola* (93T004).

A. hortensis Marshall

Liosomaphis berberidis (Kaltenbach): OR, Multnomah Co., Multnomah Falls, 9-10-94, on *Berberis* sp. (94-135). WA, Yakima Co., Yakima Arboretum, 3-VI-94, on *Berberis* sp. (94-056).

A. kakimiaphidis Smith

Kakimia aquilegiae (Essig): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Aquilegia formosa* (94K036).

Kakimia cynosbati (Oestlund): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Aquilegia formosa* (94K026).

Kakimia sp.: MT, Sanders Co., W. Fork Thompson River, 26-VII-94, on *Castilleja* sp. (94R030). WA, Yakima Co., White Pass, 22-VII-94, on *Mimulus lewisii* (94R020).

A. lupini Liu

Macrosiphum albifrons Essig: WA, Yakima Co., Bird Lake near Mt. Adams, 8-IX-94, on *Lupinus* sp. (94R163, 94R186).

A. matricariae Haliday

Brachycaudus helichrysi (Kaltenbach): WA, King Co., Redmond, 5-XI-92, on *Senecio* sp. (92L001).

Phorodon humuli (Schrank): WA, Benton Co., WSU-Prosser, 13 & 28-IX-94, on *Humulus lupulus* (94R202, 94R250).

A. ohioensis Smith

Macrosiphoniella ludovicianae (Oestlund): CA, Shasta Co., near Cayton, Northshore CG, 23-VI-94, on *Artemisia ludoviciana* (94K012).

Uroleucon ivae Robinson: WA, Benton Co., WSU-Prosser, 21-VII-94, on *Iva xanthifolia* (94R012). WA, Yakima Co., Sunnyside, 13-VII-94 (94G009), and Grandview, 29-VII-94 (94R055), on *Iva xanthifolia.*

Uroleucon sp.: WA, Yakima Co., Grandview, 23-VIII-94, on *Iva xanthifolia* (94R122).

A. polygonaphis Fitch

Macrosiphum euphorbiae (Thomas): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rosa* sp. (94K045).

A. smithi Sharma & Subba Rao

Acyrthosiphon pisum (Harris): WA, Benton Co., WSU-Prosser, 25-VIII-94, on *Medicago sativa* (94R126).

A. spp.

Acyrthosiphon pisum (Harris): WA, Benton Co., WSU-Prosser, 25-VIII-94, on *Medicago sativa* (94R126). WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rhododendron albiflorum* (94K031).

Aphis armoraciae Cowen: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Mertensia paniculata* (94K030).

Aphis varians Patch: WA, Pierce Co., Mt Rainier National Park, White River CG, 18-VIII-94, on *Epilobium angustifolium* (94R118).

Aphis sp.: ID, Latah Co., Moscow, 15-IX-93, on *Solanum lycopersicon* (93T020).

Diuraphis noxia (Kurdjumov): WA, Benton Co., WSU-Prosser, 13-VI-94, on *Triticum aestivum* (94-145).

Eoessigia longicauda (Richards): WA, Skamania Co., South Prairie, on *Spiraea douglasii* (94R192).

Hyperomyzus sp.: WA, Benton Co., WSU-Prosser, 11-VI-94, on *Sonchus oleraceus* (94-144).

Illinoia rhododendri (Wilson): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rhododendron albiflorum* (94K043).

Illinoia sp.: WA, Skamania Co., Goose Lake, 8-VI-94, on *Vaccinium* sp. (94-126).

Kakimia sp.: MT, Sanders Co., W. Fork Thompson River, 26-VII-94, *Castilleja* sp. (94R030).

Macrosiphum californicum (Clarke): WA, Kittitas Co., 7-VII-94, on *Salix* sp. (94K048).

Metopolophium dirhodum (Walker): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rhododendron albiflorum* (94K027).

Myzus sp.: WA, Whitman Co., Pullman, 14-IX-93, on *Forsythia* sp. (93T019).

Sitobion avenae (F.): WA, Asotin Co., Field Springs State Park, 5-VIII-93, on Gramineae (93T013). WA, Columbia Co., near Dayton, 16-VI-94, on *Triticum aestivum* (94T020). WA, Whitman Co., near Pullman, 5-VII-94, on *Triticum aestivum* (94T022).

Uroleucon ivae Robinson: WA, Benton Co., near Grandview, County Line Rd & I-82, 11-VIII-94, 07-IX-94, on *Iva xanthifolia* (94R094, 94R142).

Utamphorophora humboldti (Essig): OR, Multnomah Co., Multnomah Falls, 8-IV-92, on *Physocarpus* sp. (92A002).

Mixed aphids: *Chaetosiphon tetrahodum* (Walker), *Fimbriaphis wakibae* (Hottes) and *Macrosiphum euphorbiae* (Thomas), WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rosa* sp. (94K045). *Hyperomyzus lactucae* (L.) and *Uroleucon sonchi* (L.), WA, Benton Co., WSU-Prosser, 21-V-94, on *Sonchus oleraceus* (94-020).

Undetermined aphids: WA, Asotin Co., near Asotin, 9-VII-93, on *Chrysothamnus nauseosus* (93T025). WA, Kittitas Co., Lost Lake, 7-VII-94, on *Lonicera involucrata* (94K028), and near Manashtash Lake, 29-VI-93, on *Rhododendron albiflorum* (94G004).

Genus *Binodoxys* Mackauer

B. carolinensis (Smith)

Aphis varians Patch: MT, Sanders Co., W. Fork Thompson River, 26-VII-

94, on *Epilobium angustifolium* (94R029).

***B. clydesmithi* Pike & Starý, new species**
(Figs. 1–8)

Diagnosis.—Following a key by Smith (1944), the new species keys to *B. coruscanigrans* (Gahan). The latter was originally described by Gahan (1911), and later redescribed by Smith (1944) based on large series of specimens reared from *Obtusicauda coweni* Hunter (from Idaho and Utah) and *O. jonesi* (Gillette & Palmer) (from Utah). We have examined a female specimen from Smith's (1944) collection reared from *O. coweni* (Smithfield Canyon, Utah); it agrees both with the description by Gahan (1911) and the redescription by Smith. The distinguishing features of *B. coruscanigrans* are: number and arrangement of setae on prong (Fig. 9), i.e. 4–5 setae, similar in length, and situated on basal two-thirds of prong; seta at prong apex stout, lanceolate, horizontal; ovipositor sheath almost claw-shaped (Fig. 10); spiracular and secondary tubercles of equal size, distinctly separated on metasomal tergum 1; coloration of metasoma yellow on distal fourth, especially lateral and lower portions; ovipositor sheath and prong piceous. *B. clydesmithi* differs from *B. coruscanigrans* in that the prongs are comparatively more stout, bear more dorsal setae, and with only a simple seta at apex; ovipositor sheath not claw-shaped; spiracular and secondary tubercles closely spaced on metasomal tergum 1; and coloration of metasoma, ovipositor sheath and prong dark brown. Both species are associated with sagebrush aphids and probably, or at least partially overlap in their distribution in the Pacific Northwest.

Etymology.—The new species is named in honor of Clyde F. Smith who has contributed substantially to the research on Nearctic Aphidiinae parasitoids.

Description.—*Female.* Head. Tentorioocular line ¾ malar space, slightly longer than ⅙ eye length, shorter than ⅓ intertentorial line. Antenna 11-segmented, reaching to end of metasomal tergum 2, width increasing towards apex. Flagellomere 1 (=F_1) (Fig. 2) length 3.5× width, setae about half segmental width, without longitudinal placodes. F_2 (Fig. 3) length equal to width, subequal to length of F_1. F_5 (Fig. 5) length slightly >2× width, about ⅓ wider than F_1. F_8 (Fig. 6) length slightly >2× width, wider than F_5.

Mesosoma. Mesonotal setae relatively sparse, effacing notauli on disc. Propodeum (Fig. 4) smooth, setae sparse, indications of divergent carinae in lower portion.

Forewing (Fig. 1). Stigma length 3× greatest width; distal abscissa of R1 (= metacarpus) equal to about ⅔ stigma length; lower marginal setae 4× longer than surface setae.

Legs. Hind femur with adpressed setae ⅓ segmental width.

Metasoma. Metasomal tergum 1 (Fig. 8) 1.5× as long as width at spiracles; spiracular tubercles poorly prominent in comparison with secondary tubercles; distance between spiracular and secondary tubercles ⅙ width between spiracles.

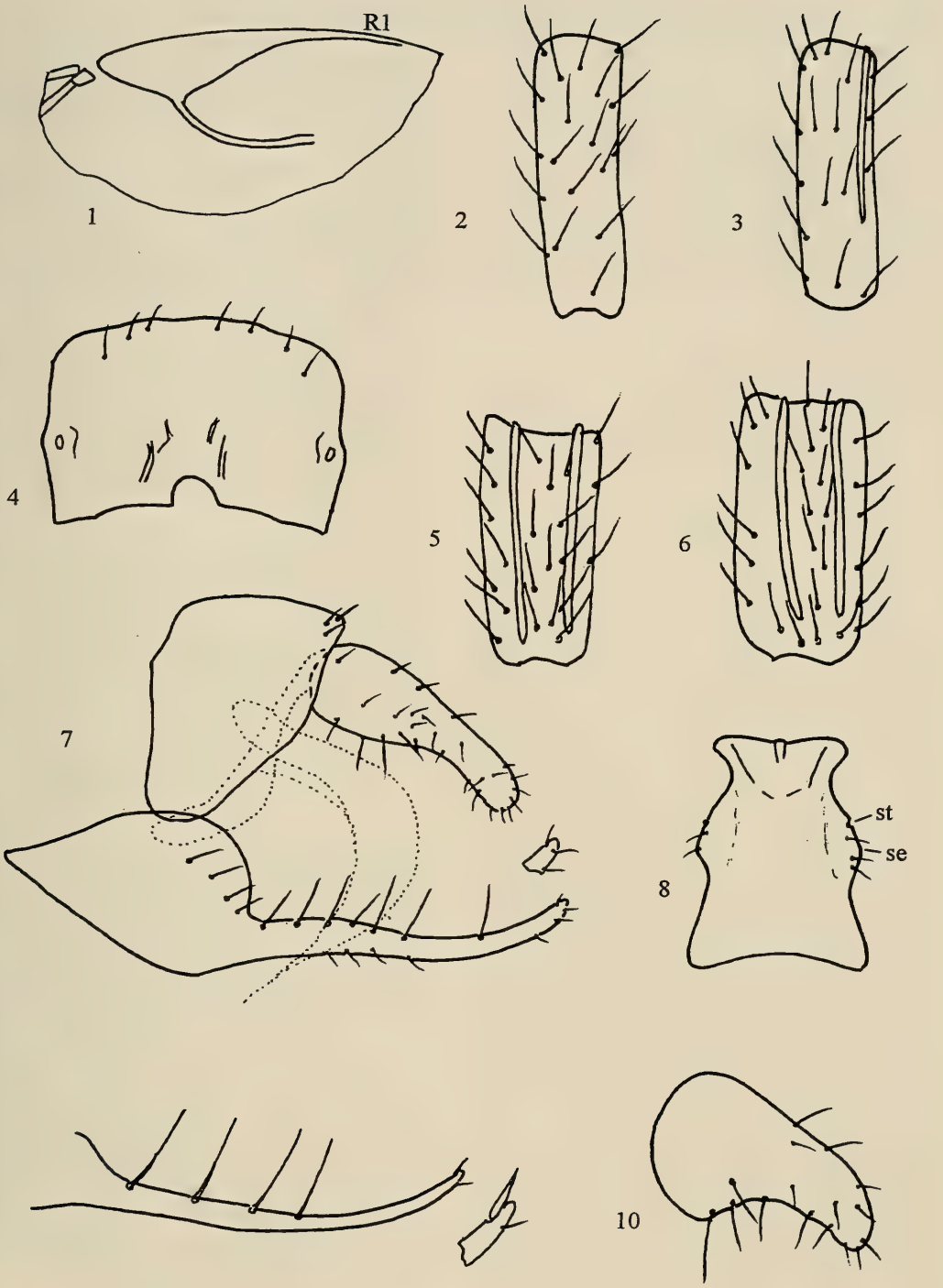
Genitalia (Fig. 7). Prong with 7 long setae on dorsal margin, a few shorter setae on ventral margin, and two simple oblique setae at apex.

Coloration. Head dark brown, mouthparts yellowish. Antennal scape, pedicel, F_1 and F_2 yellow, remaining segments brown. Mesosoma dark brown. Wings subhyaline, venation light brown. Middle and hind legs brown to dark brown; trochanter, trochantellus and base of tibia lighter. Metasoma dark brown; apex of tergum 1 and center of terga 2–3 yellow brown; ovipositor sheath and prong dark brown.

Length of body about 1.6 mm.

Male. Antenna 13-segmented, brown, pedicel yellowish; otherwise coloration similar to female.

Holotype [♀].—USA, WA, Kittitas Co., Lost Lake, 7-VII-1994, coll. K. Pike & G. Graf. Host: *Obtusicauda coweni* Hunter and



Figs. 1–10. 1-8, *Binodoxys clydesmithi,* ♀ paratypes (illustrations not to equal scale). 1, Forewing, in part. 2, Flagellomere 1. 3, Flagellomere 2. 4, Propodeum. 5, Flagellomere 5. 6, Flagellomere 8. 7, Genitalia. 8, Metasomal tergum 1. Abbreviations: R1, postmarginal vein; Se, secondary tubercle; St, spiracular (= primary) tubercle. 9-10, *B. coruscanigrans,* ♀ (illustrations not to equal scale). 9, Prong. 10, Ovipositor sheath.

Zyxaphis oregonensis Wilson on *Artemisia tridentata,* sample no. 94K042. Deposited in USNM.

Paratypes.—1 ♀, 2 ♂♂ (pinned), same data as holotype. Deposited in the Washington State University Collection, James Museum, Pullman, Washington; additional material deposited in the Washington State University Collection-Prosser, WA, and the collection of P. Starý, České Budějovicé, Czech Republic.

B. conei Pike & Starý

Phorodon humuli (Schrank): WA, Benton Co., WSU-Prosser, 7-IX-94, on *Humulus lupulus* (94W004) [see Pike & Starý 1995a].

***B. grafi* Pike & Starý, new species**
(Figs. 11–13).

Diagnosis.—The new species has a number of features (areolated propodeum, nearly unicolorous metasoma, 11-segmented antenna, metacarpus/pterostigma length/width ratio) in common with *B. carolinensis* (Smith) (1944) and *B. nearctaphidis* Mackauer (1965), but differs markedly in the shape of metasomal tergum 1. With *B. carolinensis,* primary (= spiracular) and secondary tubercles are equally sized, but with *B. grafi* primary tubercle separation is ¼ to ⅓ less than secondary tubercles. With *B. nearctaphidis,* primary and secondary tubercle separation is less than ½ width across spiracles, prong straight with one basally dilated perpendicular seta close to a simple apical seta (for description and illustration, see Mackauer 1956); with *B. grafi* primary and secondary tubercle separation is about ¾ width across spiracles, prong slightly arcuate with two simple oblique apical setae.

Etymology.—The name of the species is in honor of George Graf, Washington State University Research Technician who participated in the first collection of the new species.

Description.—*Female.* Head. Antenna 11-segmented, reaching to slightly beyond metasomal tergum 1, width increasing towards apex. Flagellomere 1 (=F_1) length 3× width, with 1 longitudinal placode. F_2 equal to F_1 in size, with 3 longitudinal placodes. F_5 slightly more than twice as long as wide. F_8 length 2× width, slightly wider than F_5, ⅓ wider than F_1.

Mesosoma. Mesonotum with notauli crenulate in ascendent portion, effaced on disc as indicated by a row of sparse setae. Propodeum with distinct complete pentagonal areola.

Forewing (Fig. 11). Stigma length 3× width, distal abscissa of R1, ⅓ shorter than stigma; Rs slightly longer than stigma, and 3× stigma width; lower marginal setae three times as long as surface setae.

Legs. Hind femur with short adpressed setae.

Metasoma. Tergum 1 (Fig. 12) length about 2.5× width at spiracles, with coarse longitudinal rugosities in middle third; secondary tubercles prominent, about ¼ to ⅓ wider than across primary (= spiracular) tubercles; distance between primary and secondary tubercles about ¼ less than width across primary tubercles.

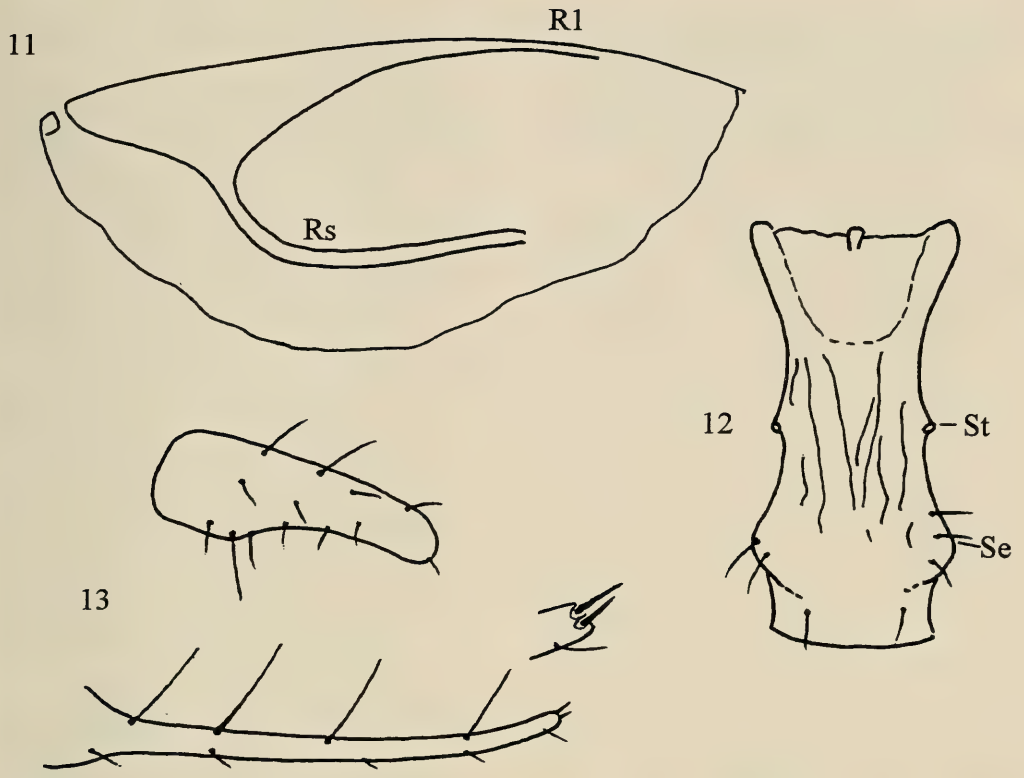
Genitalia (Fig. 13). Prong slightly arcuate, with four semi-erect long setae on upper margin that are several times longer than prong diameter; 4 oblique shorter setae on lower margin about equal to prong diameter; with two simple oblique setae or bristles at apex.

Coloration. Head dark brown, clypeus and malar space light brownish; mouthparts yellowish. Antenna brown except scape, pedicel and F_1 yellowish. Mesosoma dark brown, prothorax brownish. Wing venation light brown. Leg yellow; middle and hind coxa, and tarsal apex somewhat darker. Metasoma brown; tergum 1 and central portion of tergum 2 yellow brown; apex of metasoma lighter, basal ⅔ of prong yellowish.

Length of body about 1.9 mm.

Male. Unknown.

Holotype [♀].—USA, WA, Kittitas Co., Lost Lake, 7-VII-1994, coll. K. Pike & G. Graf. Host: *Aphis helianthi* Monell, *Aphis* nr. *varians* Patch, *Aphis* sp. on *Epilobium an-*



Figs. 11–13. *Binodoxys grafi*, ♀ (illustrations not to equal scale). 11, Forewing, in part. 12, Metasomal tergum 1. 13, Genitalia, in part. Abbreviations: R1, postmarginal vein; Rs, Radial sector; Se, secondary tubercle; St, spiracular (= primary) tubercle.

gustifolium, sample no. 94K056. Deposited in USNM. Additional material deposited in part in the Washington State University Collection, James Museum, Pullman, WA; the Washington State University Collection-Prosser, WA; and the collection of P. Starý, České Budějovicé, Czech Republic.

B. sp.

Aphis salicariae Koch: WA, Yakima Co., Ahtanum Valley, 3-VI-94, on *Cornus stolonifera* (94-064).

Illinoia rhododendri (Wilson): WA, Kittitas Co., 7-VII-94, on *Rhododendron albiflorum* (94K043).

Genus *Diaeretiella* Starý

D. rapae (M'Intosh)

Brachycorynella asparagi (Mordvilko): WA, Benton Co., WSU-Prosser, 13-IX-94, on *Asparagus officinalis* (94R203).

Braggia sp.: WA, Yakima Co., Naches, 9-VI-94, on *Eriogonum elatum* (94-139).

Brevicoryne brassicae (L.): WA, Benton Co., Prosser, 11-X-94, on *Brassica oleracea* (94K117); 27-V-94, 15-VI-94, on *Brassica napus* (94-041, 94K003); and 27-V-94, on *Descuraina sophia* (94-042). WA, Skagit Co., Mt Vernon, 8-IX-94, on *Brassica oleracea* coll. A. Anderson (94R201). WA, Whitman Co., Pullman, 13-VII-93, on *Brassica napus* (93T005).

Diuraphis noxia (Kurdjumov): WA, Adams Co., near Ritzville, 15-VI-91 (91A017), and LaCross, 25-V-94 (94-038), on *Triticum aestivum.* WA,

Asotin Co., near Anatone, 1993, on *Triticum aestivum* (93T006). WA, Benton Co., Gap & Snipes Rd, 7-V-91 (91A011), Horse Heavens, 14-VI-94 (94K001, 94K002), WSU-Prosser, XI-89, 23-IV-91, 7 & 20-V-91, 8-VIII-91, 17 & 24-IV-92, 1-V-92, 17, 24, 25 & 27-V-94, 13-VI-94, 17 & 28-X-94 (89A002, 89A003, 91A004-91A006, 91A008-91A016, 91A018, 92A005, 92A009, 92K001, 94-006, 94-030, 94-031, 94-045, 94-145, 94G086, 94G094), on *Triticum aestivum,* and 17 & 31-V-94, 2-VI-94 on *Hordeum vulgare* (94-011, 94-049, 94-050). WA, Franklin Co., Kahlotus, 4-VI-91, on *Triticum aestivum* (91A016). WA, Klickitat Co., Bickleton, 7-VI-94, 1-VII-94, on *Triticum aestivum* (94-088, 94K097); 7-VI-94, on *Aegilops cylindrica* (94-089); and Goldendale, 7-VI-94, on *Triticum aestivum* (94-103). WA, Whitman Co., Colfax, 29-VI-94 (94K017), near Dusty, 23-VIII-93 (93T007), and near Pullman, 5-VII-94 (94T021), on *Triticum aestivum.* WA, Yakima Co., Donahoe Rd., 18-VI-94, on *Hordeum vulgare* (94G001), and Glade Rd, 7-VI-94 (94-087), Grandview, 29-V-94 (94-047), and Sunnyside, 10-X-94 (94G074) on *Triticum aestivum.*

Hayhurstia atriplicis (L.): WA, Yakima Co., near Sunnyside, 3 & 25-IX-94, 10-X-94, on *Chenopodium album* (94G015, 94G028, 94G071).

Macrosiphum euphorbiae (Thomas): WA, Pierce Co., Mt. Rainier National Pk, White River CG, 18-VIII-94, on *Epilobium angustifolium* (94R117).

Macrosiphum sp.: WA, Asotin Co., near Field Springs State Pk, 24-VIII-93, on *Triticum aestivum* (93T015).

Myzus persicae (Sulzer): WA, Benton Co., WSU-Prosser, 2-XI-94, on *Brassica* sp. (94A004). WA, Skagit Co., Mt. Vernon, 8-XI-94, on *Brassica oleracea,* coll. A. Anderson (94R201).

Myzus sp.: WA, Whitman Co., Pullman, 14-IX-93, on *Forsythia* sp. (93T019).

Phorodon humuli (Schrank): WA, Benton Co., WSU-Prosser, 13-IX-94, 7-XI-94, on *Humulus lupulus,* coll. W. Cone (94R202, 94W004).

Rhopalosiphum maidis (Fitch): WA, Benton Co., WSU-Prosser, 21-X-94, 23-XI-94, on *Panicum milliaceum* (94G093, 94G106).

Rhopalosiphum padi (L.): WA, Benton Co., WSU-Prosser, 17-IV-92, 1 & 8-V-92, 27-V-94, 17-X-94 on *Triticum aestivum* (92A004, 92A006, 92A012, 92A017, 92A018, 94-045, 94G086), and 27-V-94, on *Hordeum vulgare* (94-043). WA, Yakima Co., near Sunnyside, 10-X-94, on *Triticum aestivum* (94G074).

Sitobion avenae (F.): WA, Benton Co., WSU-Prosser, 27-VI-94, on *Triticum aestivum* (94K098). WA, Klickitat Co., near Bickleton, 1-VII-94, on *Triticum aestivum* (94K097). WA, Whitman Co., near Pullman, 19-VII-93, on *Triticum aestivum* (93T012).

Mixed aphids: *Diuraphis noxia* (Kurdjumov), *Rhopalosiphum padi* (L.), *Sitobion avenae* (F.), WA, Klickitat Co., Bickleton, 23-VII-93, on *Hordeum vulgare* (93K006), and *Triticum aestivum* (93K007).

Genus *Ephedrus* Haliday

E. californicus Baker

Acyrthosiphon latucae (Passerini): WA, Asotin Co., near Anatone, 10-IX-93, on *Lactuca serriola* (93T018).

Aphthargelia symphoricarpi (Thomas): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Symphoricarpos* sp. (94K047, 94K050).

Chaetosiphon fragaefolii (Cockerell): ID, Boundary Co., Kootenay Wildlife Refuge, 26-VII-94, on *Rosa* sp. (94R026a).

Macrosiphum euphorbiae (Thomas): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rosa* sp. (94K045). WA, Yakima Co., Bird Creek Meadows, 8-IX-94, on *Ligusticum grayi* (94R175).

Macrosiphum rosae (L.): WA, Yakima Co., Grandview, 25-V-94, 25-IX-94 on *Rosa* sp. (94-028, 94G023).

Uroleucon russellae (Hille Ris Lambers): MT, Sanders Co., W. Fork Thompson River, 26-VII-94, on *Anaphalis margaritacea* (94R028).

Uroleucon sp.: WA, Asotin Co., 7-IX-93, on *Dipsacus sylvestris* (93T009). WA, Yakima Co., Tampico, 20-VII-94, on *Aster* sp. (94R002).

Mixed aphids: *Chaetosiphon tetrahodum* (Walker), *Fimbriaphis wakibae* (Hottes), and *Macrosiphum euphorbiae* (Thomas), WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rosa* sp. (94K045).

Undetermined aphid: WA, Asotin Co., 7-IX-93, on *Dipsacus sylvestris* (93T008).

E. spp.

Aphis coweni Palmer: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Veratrum viride* (94K049).

Aphis varians Patch: MT, Sanders Co., W. Fork Thompson River, 26-VII-94 (94R029), and Thompson Pass, 27-VII-94 (94R040), on *Epilobium angustifolium.*

Uroleucon sp.: WA, Whitman Co., Pullman, 25-IX-93, on *Lactuca serriola* (93T023).

Mixed aphids: *Illinoia rhododendri* (Wilson) and undetermined sp., WA, Yakima Co., Bird Creek Meadows, 9-IX-94, on *Vaccinium* sp. (94R177).

Genus *Euaphidius* Mackauer

E. cingulatus (Ruthe)

Pterocomma bicolor (Oestlund): WA, Pierce Co., Mt. Rainier National Pk, Westside Rd., 15-IX-94, on *Salix* sp. (94R207, 94R209).

Pterocomma sp.: OR, Multnomah Co., Multnomah Falls, 4-IV-92, on *Salix* sp. (92A003).

E. setiger (Mackauer)

Periphyllus lyropictus (Kessler): WA, Benton Co., WSU-Prosser, 28-V-94, on *Acer platanoides* (94-046).

Genus *Lysiphlebus* Förster

L. flavidus Gahan

Cedoaphis incognita Hottes & Frison: WA, Yakima Co., Clear Lake, 24-VI-92, on *Symphoricarpos* sp. (92A001).

L. testaceipes (Cresson)

Acyrthosiphon lactucae (Passerini): WA, Asotin Co., near Anatone, 10-IX-93, on *Lactuca serriola* (93T018). WA, Kittitas Co., Ellensburg, 26-IX-94, on *Lactuca serriola* (94G041).

Aphis armoraciae Cowen: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Mertensia paniculata* (94K030).

Aphis helianthi Monell: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Heracleum lanatum* (94K032). WA, Pierce Co., Mt. Rainier National Pk, Cayuse Pass, 2-VIII-94, on *Cirsium* sp. (94R064), and 11 & 18-VIII-94, on *Heracleum lanatum* (94R091, 94R108, 94R110). WA, Pierce Co., Crystal Mt., 3-VIII-94, on *Heracleum lanatum* (94R081). WA, Skamania Co., Trout Lake, 8-VI-94, on *Ligusticum apiifolium* (94-113). WA, Yakima Co., Ravens Roost, 10-VII-94, on *Cirsium* sp. (94G008).

Aphis holodisci Robinson: WA, Yakima Co., Ahtanum Valley, 3-VI-94, on *Holodiscus discolor* (94-076).

Aphis lugentis Williams: WA, Yakima Co., Bird Creek Meadows, 8-IX-94, on *Arnica* sp. (94R171), and *Senecio triangularis* (94R179), and Bird

Lake, 8-IX-94, on *Senecio triangularis* (94R165).

Aphis neogillettei Palmer: WA, Skamania Co., Trout Lake, 8-VI-94, on *Cornus stolonifera* (94-119).

Aphis nerii Boyer de Fonscolombe: WA, Benton Co., County Line Rd & I-82, 7-IX-94 (94R143), and Prosser, 10-IX-94 (94G016), on *Asclepias speciosa.* WA, Yakima Co., near Sunnyside, 10-VIII-94, 3-X-94 on *Asclepias speciosa* (94G013, 94G065).

Aphis rumicis L.: WA, Benton Co., WSU-Prosser, 17-V-94, on *Rumex crispus* (94-008).

Aphis sambuci L.: WA, Pierce Co., Mt. Rainier National Pk, near Paradise, 29-IX-94, on *Sambucus racemosa* (94R263).

Aphis spiraecola Patch: WA, Benton Co., Hanford ALE, 29-VIII-94, on *Lactuca serriola* (94K112).

Aphis varians Patch: MT, Sanders Co., W. Fork Thompson River, 26-VII-94, on *Castilleja* sp. (94R029). WA, Pierce Co., Mt. Rainier National Pk, Cayuse Pass, 2-VIII-94 (94R065), and White River CG, 18-VIII-94 (94R118), on *Epilobium angustifolium.* WA, Yakima Co., Green Lake, 31-VIII-94, on *Epilobium angustifolium* (94R140).

Aphis sp.: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Pedicularis bracteosa* (94K029), and *Senecio triangularis* (94K039). WA, Klickitat Co., Glennwood, 8-IX-94, on *Rheum rhabarbarum* (94R155). WA, Yakima Co., Green Lake Rd, 31-VIII-94, on Umbelliferae (94R137).

Aphthargelia symphoricarpi (Thomas): WA, Kittitas Co., Lost Lake, 29-VI-94, 7-VII-94, on *Symphoricarpos* sp. (94G005, 94K047, 94K050). WA, Skamania Co., Trout Lake, 8-VI-94, on *Symphoricarpos albus* (94-116).

Brachycaudus cardui L.: WA, Benton Co., Bennett Springs, 4-X-94, on *Cirsium vulgare* (94G069).

Brachycaudus helichrysi (Kaltenbach): WA, Kititas Co., Manashtash, 26-IX-94, on *Rudbeckia hirta* (94G042).

Brachycaudus tragopogonis (Kaltenbach): WA, Klickitat Co., Glenwood, 8-IX-94, on *Tragopogon dubius* (94R150).

Brachycorynella asparagi (Mordvilko): WA, Benton Co., WSU-Prosser, 13-IX-94, on *Asparagus officinalis* (94R203).

Braggia eriogoni (Cowen): WA, Klickitat Co., Bickleton, 7-VI-94, on *Eriogonum heracleoides* (94-094).

Braggia sp.: WA, Yakima Co., Ahtanum Valley, 3-VI-94, on *Eriogonum compositum* (94-73), and Naches, 9-VI-94, on *Eriogonum elatum* (94-139).

Diuraphis noxia (Kurdjumov): WA, Benton Co., Gap & Snipes Rd, 23-IV-91 (91A007), WSU-Prosser, 23-IV-91, 17 & 24-IV-92, 1-V-92, 28-X-94 (91A004, 91A005, 91A008, 92A005, 92A009, 92A011, 94G094), on *Triticum aestivum.* WA, Yakima Co., near Sunnyside, 8 & 30-VI-94, 10-X-94, on *Triticum aestivum* (94A007, 94A009, 94G074).

Macrosiphum euphorbiae (Thomas): WA, Pierce Co., Mt. Rainier National Pk, White River CG, 18-VIII-94, on *Epilobium angustifolium* (94R117).

Myzus ascalonicus Doncaster: WA, Yakima Co., White Pass, 18-VIII-94, on moss (94R106).

Nearctaphis clydesmithi Hille Ris Lambers: WA, Klickitat Co., Brooks Memorial Pk, 8-VI-94, on *Crataegus douglasii* (94-100).

Phorodon humuli (Schrank): WA, Benton Co., WSU-Prosser, 23-V-94, on *Prunus salicina* (94-026). WA, Benton Co., WSU-Prosser, 13 & 28-IX-94, on *Humulus lupulus* (94R202, 94R250).

Rhopalosiphum maidis (Fitch): WA, Benton Co., Bennett Springs, 4-X-94, on *Echinochloa crus-galli* (94G066); WSU-Prosser, XI-89, on *Triticum*

aestivum (89A001) and 21 & 23-X-94, on *Panicum milliaceum* (94G093, 94G105, 94G106).

Rhopalosiphum padi (L.): WA, Benton Co., Bennett Springs, 4-X-94, on *Echinochloa crus-galli* (94G066); WSU-Prosser, 17 & 24-IV-92, 1-V-92, 25-VIII-92 on *Triticum aestivum* (92K002, 92A006, 92A007, 92A012, 92A017), and 17-X-94, on *Zea mays* (94G085). WA, Yakima Co., near Sunnyside, 10-X-94, on *Triticum aestivum* (94G074).

Sitobion avenae (F.): WA, Asotin Co., near Anatone, 12-VII-94, on *Triticum aestivum* (94T023).

Uroleucon cirsii? (L.): WA, Pierce Co., Mt. Rainier National Pk, Longmire, 15-IX-94, on *Cirsium arvense* (94R212).

Undetermined aphids: WA, Asotin Co., near Anatone, 15-IX-93, on *Helianthus* sp. (93T021); near Asotin, 7-IX-93, on *Chrysothamnus nauseosus* (93T026); and Field Springs State Pk, 5 & 24-VIII-93, on *Cirsium arvense* (93T010, 93T014). WA, Benton Co., Bennett Springs, 4-X-94, on *Cirsium vulgare* (94G068); Rattlesnake Hills, 27-IX-94, swarm above *Triticum aestivum* stubble (94G040). WA, Whitman Co., near Dusty, 7-VII-93, on *Lupinus* sp. (93T011).

L. sp.

Aphis helianthi Monell: WA, Pierce Co., Mt. Rainier National Pk, near Cayuse Pass, 11-VIII-94, on *Heracleum lanatum* (94R091).

Aphis sp.: WA, Pierce Co., Mt. Rainier National Pk, near Cayuse Pass, 11-VIII-94, on *Heracleum lanatum* (94R091). WA, Yakima Co., Green Lake, 31-VIII-94, on Umbelliferae (94R137).

Brachycaudus tragopogonis (Kaltenbach): WA, Klickitat Co., Glenwood, 8-IX-94, on *Tragopogon dubius* (94R150).

Genus *Monoctonus* Haliday

M. washingtonensis Pike & Starý

Diuraphis noxia (Kurdjumov): WA, Benton Co., WSU-Prosser, Roza Farm, 17-IV-92, on *Triticum aestivum* (92A005) [see Pike & Starý 1995b].

Rhopalosiphum padi (L.): WA, Benton Co., WSU-Prosser, 1, 8 & 15-V-92, on *Triticum aestivum* (92A017–92A019) [see Pike & Starý 1995b].

M. sp.

Acyrthosiphon pisum (Harris): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rhododendron albiflorum* (94K031).

Illinoia rhododendri (Wilson): WA, Kittatas Co., Lost Lake, 7-VII-94, on *Rhododendron albiflorum* (94K043).

Illinoia sp.: WA, Yakima Co., Green Lake, 20-VII-94, on *Rhododendron albiflorum* (94R006).

Metopolophium dirhodum (Walker): WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rhododendron albiflorum* (94K027).

Genus *Pauesia* Quilis

P. ahtanumensis Pike & Starý

Cinara ponderosae (Williams): WA, Skamania Co., Trout Lake, 8-VI-94, on *Pinus ponderosa* (94-107). WA, Yakima Co., Ahtanum Valley, 3-VI-94, on *Pinus ponderosa* (94-065, 94-066) [see Pike & Starý 1996].

P. pahtonis Pike & Starý

Cinara ponderosae (Williams): WA, Skamania Co., Goose Lake, 8-VI-94, on *Pinus ponderosa* (94-131) [see Pike & Starý 1996].

P. ponderosaecola Pike & Starý

Cinara ponderosae (Williams): WA, Skamania Co., Trout Lake, 8-VI-94, on *Pinus ponderosa* (94-107, 94-112).

WA, Yakima Co., Ahtanum Valley, 3-VI-94, on *Pinus ponderosa* (94-065, 94-066) [see Pike & Starý 1996].

***P. pseudotsugae* Pike & Starý, new species** (Figs. 14–24)

Diagnosis.—According to a key by Smith (1944) the new species keys to *P. gillettei* (Gahan), but differs from it in the number of antennal segments (*P. pseudotsugae* [♀], 24 segments; *P. gillettei* [♀], 21 segments).

Etymology.—The name of the new species is derived from the association of its host aphid *Cinara pseudotaxifoliae* Palmer on Douglas fir, *Pseudotsuga menziesii.*

Description.—*Female.* Head. Tentorioocular line ⅓ shorter than intertentorial line, and slightly shorter than malar space. Eye length 3× malar space. Eyes with sparse short setae. Antenna 24-segmented, filiform, slightly thinned in apical half (Fig. 21–24). Flagellomere 1–10 equal in length, each about 1.5× as long as wide, remaining flagellomeres gradually decreasing in length to apex. Flagellomeres in apical half slightly narrower than basal portion.

Mesosoma. Mesonotum (Fig. 15) with crenulate-rugose notauli distinct in ascendent portion; surface delicately granularly punctate, sparsely setose along effaced notauli on disc; central lobe with longitudinal glabrous spot; lateral lobes with small glabrous areas. Propodeum (Fig. 17) with distinct, broad, deeply excavated, smooth, glabrous areola; lateral rami well developed, longitudinal rami somewhat incomplete but distinct; lateral upper areolae with relatively dense long setae.

Forewing (Fig. 16): Stigma about 2.5× as long as wide, distal abscissa of R1 about ⅙ shorter than stigma; rs vein distinctly shorter than width of stigma, about 1.5× as long as 3/Rs; 2/Rs subequal to half of rs; lower margin setae twice as long as surface setae.

Leg. Hind femur with adpressed setae on the upper margin and erect setae on the lower margin. Hind tibia with adpressed setae on both margins.

Metasoma. Tergum 1 (Fig. 14) slender, length 3.5× width at spiracles, width at apex <2× width at spiracles; spiracular tubercles prominent laterally; longitudinally rugose, with distinctly prominent longitudinal keeliform rugosity in middle third of tergum, and with sparse long setae.

Genitalia (Figs. 18–20): Ovipositor sheath broad, apical setae with tubiform base.

Coloration. Head yellow orange, occipital area brown; mouthparts bright yellow. Antennal scape yellow-orange, pedicel brown with yellow orange rings at each end, remaining segments dark brown. Mesosoma distinctly bicolorous, prevalently yellow orange. Prothorax, mesonotum yellow orange. Mesopleuron yellow orange with brown in central and lower portion. Scutellum brown with yellow orange in center. Metanotum and metapleuron brown. Propodeum brown and yellow orange; upper lateral areolae and lower corners of lower areola brown. Stigma bicolorous, brown with yellowish base. Legs yellow, apex of hind tarsi and tibiae brownish. Metasoma yellow orange; tergum 1 with somewhat darkened apex; terga 2 and 3 with darkened central spots, remaining terga with brownish banding in distal third. Ovipositor sheath brown.

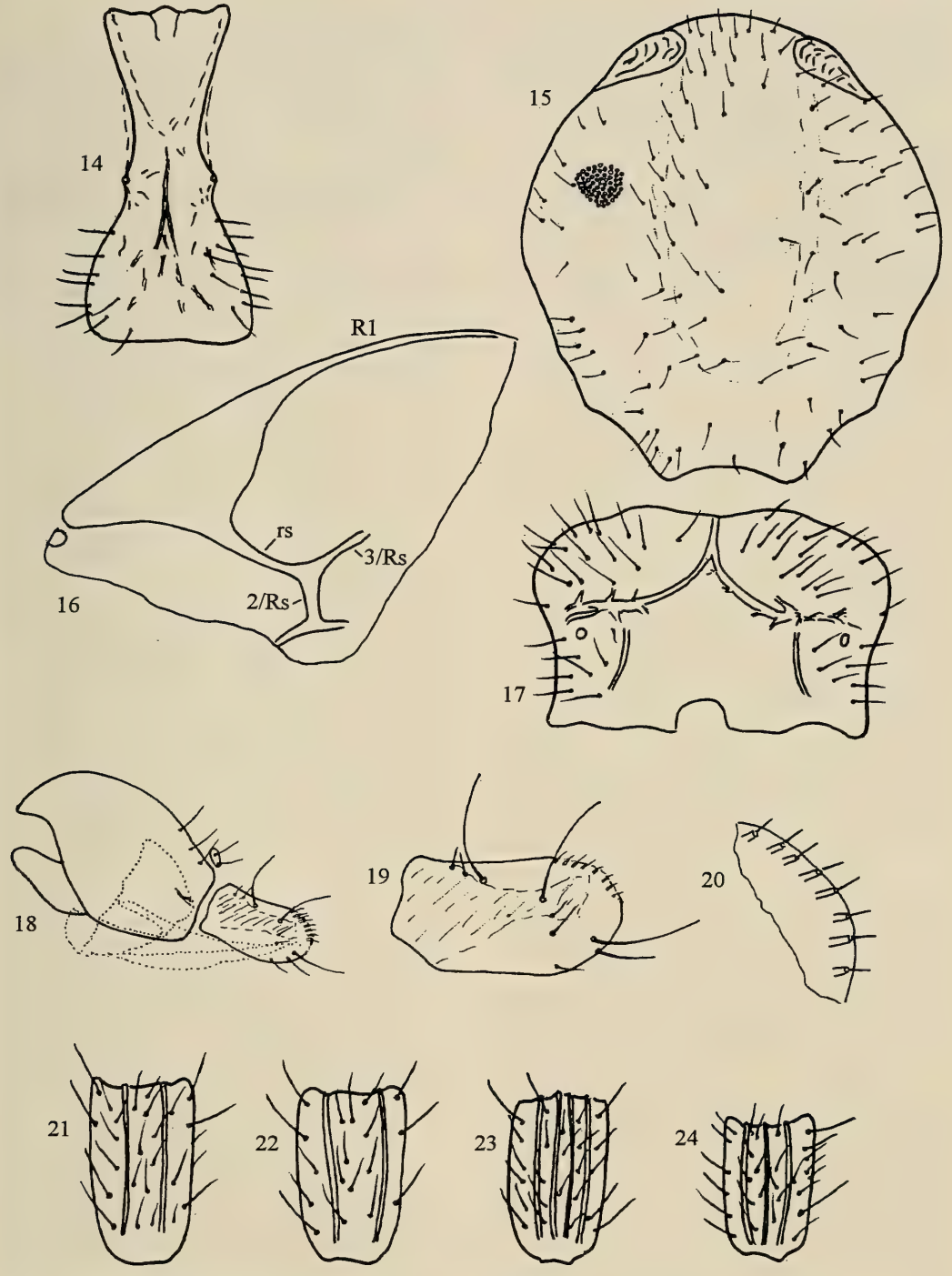
Length of body about 4.5 mm.

Male: Unknown.

Holotype [♀].—USA, WA, Kittitas Co., Lost Lake, 7-VII-1994, coll. K. Pike & G. Graf.

Host.— *Cinara pseudotaxifoliae* Palmer on *Pseudotsuga menziesii,* sample no. 94K025. Deposited in USNM.

Paratype.—♀ (mounted on slide), same data as holotype. In the collection of P. Starý, České Budějovicé, Czech Republic. Additional material deposited in the Washington State University Collection, James Museum, Pullman, Washington, and Washington State University Collection–Prosser, WA.



Figs. 14-24. *Pauesia pseudotsugae,* ♀ paratypes (illustrations not to equal scale). 14, Metasomal tergum 1. 15, Mesonotum; granularly punctate structure drawn for left lobe only. 16, Forewing, in part. 17, Propodeum. 18, Genitalia. 19, Ovipositor sheath. 20, Apex of ovipositor sheath. 21, Flagellomere 2. 22, Flagellomere 4. 23, Flagellomere 12. 24, Flagellomere 18. Abbreviations: R1, postmarginal vein; rs, 2/Rs, and 3/Rs, wing veins.

P. juniperaphidis (Gahan)

Cinara pilicornis (Hartig): WA, Yakima Co., Yakima Arboretum, 3-VI-94, on *Picea pungens* (94-061).

P. sp.

Cinara pseudotsugae (Wilson): WA, Yakima Co., Ahtanum Valley, 3-VI-94, on *Pseudotsuga menziesii* (94-078).

Genus *Praon* Haliday

P. exsoletum (Nees)

Therioaphis trifolii maculata (Buckton): WA, Benton Co., WSU-Prosser, 17-V-94, 25-VIII-94, on *Medicago sativa* (94-014, 94R126).

P. occidentale Baker

Aphis sp.: WA, Yakima Co., Bird Creek Meadows, 8-IX-94 on *Arnica* sp. (94R172).

Diuraphis noxia (Kurdjumov): WA, Benton Co., WSU-Prosser, 17-IV-92, 1-V-92, on *Triticum aestivum* (92A005, 92A014, 92A016).

Illinoia sp.: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Aquilegia formosa* (94K036).

Macrosiphum rosae (L.): WA, Yakima Co., Grandview, 25-V-94, 25-IX-94, on *Rosa* sp. (94-029, 94G023).

Rhopalosiphum padi (L.): WA, Benton Co., WSU-Prosser, 24-IV-92, 8-V-92, on *Triticum aestivum* (92A010, 92A018).

Uroleucon sp.: WA, Skamania Co., South Prairie, 8-IX-94, on *Aster* sp. (94R190).

P. pequodorum Viereck

Acyrthosiphon pisum (Harris): WA, Benton Co., WSU-Prosser, 25-VIII-94, on *Medicago sativa* (94R124).

Uroleucon ivae Robinson: WA, Yakima Co., Sunnyside, 13-VII-94, on *Iva xanthifolia* (94G009).

P. unicum Smith

Acyrthosiphon latucae (Passerini): WA, Kittitas Co., Ellensburg, 26-IX-94, on *Lactuca serriola* (94G041).

Aphis coweni Palmer: WA, Skamania Co., Taklakh Lake, 16-VIII-94, on *Veratrum viride* (94G014). WA, Yakima Co., Bird Creek Meadows, 8-IX-94, on *Veratrum viride* (94R174).

Aphis rumicis L.: WA, Benton Co., WSU-Prosser, 21-V-94, on *Rumex crispus* (94-022, 94-025).

Diuraphis noxia (Kurdjumov): WA, Benton Co., WSU-Prosser, 17-IV-92, 1-V-92, 25-V-94, on *Triticum aestivum* (92A005, 92A016, 94-030).

Macrosiphum euphorbiae (Thomas): WA, Yakima Co., Grandview, 27-X-94, on *Solanum lycopersicum* (94R267).

Rhopalosiphum maidis (Fitch): WA, Benton Co., WSU-Prosser, XI-94, on *Panicum milliaceum* (94G107).

Rhopalosiphum padi (L.): WA, Benton Co., WSU-Prosser, 17 & 24-IV-92, 1, 8 & 15-V-92, on *Triticum aestivum* (92A006, 92A008, 92A010, 92A015, 92A017–92A019), and 27-V-94, on *Hordeum vulgare* (94-043).

P. yakimanum Pike & Starý

Diuraphis noxia (Kurdjumov): WA, Benton Co., WSU-Prosser, 25-V-94, on *Triticum aestivum* (94-031) [see Pike & Starý 1995b].

Rhopalosiphum padi (L.): WA, Benton Co., Horse Heavens, 1-V-92 (92A013); WSU-Prosser, 17-IV-92, 1-V-92, 1-V-93, on *Triticum aestivum* (92A006, 92A017, 93A002), and 27-V-94, on *Hordeum vulgare* (94-043) [see Pike & Starý 1995b].

P. spp.

Acyrthosiphon pisum (Harris): MT, Sanders Co., Plains, 26-VII-94, on *Lathyrus odoratus* (94R034).

Aphis armoraciae Cowen: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Mertensia paniculata* (94K030).

Aphis coweni Palmer: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Veratrum viride* (94K049).

Aphis pomi de Geer: WA, Yakima Co., Sunnyside, 25-IX-94, on *Pyrus malus* (94G029).

Aphthargelia symphoricarpi (Thomas): WA, Kittitas Co., Lost Lake, 29-VI-94, on *Symphoricarpos* sp. (94G005).

Ceruraphis viburnicola (Gillette): WA, Skamania Co., South Praire, 8-IX-94, on *Carex* sp. (94R191).

Chaetosiphon fragaefolii (Cockerell): ID, Boundary Co., Kootenay Wildlife Refuge, 26-VII-94, on *Rosa* sp. (94R026a).

Eoessigia longicauda (Richards): WA, Skamania Co., South Prairie, 8-IX-94, on *Spiraea* sp. (94R194).

Hyperomyzus sp.: WA, Benton Co., WSU-Prosser, 11-VI-94, on *Sonchus oleraceus* (94-144).

Illinoia rhododendri (Wilson): WA, Kittatas Co., Lost Lake, 7-VII-94, on *Rhododendron albiflorum* (94K043).

Macrosiphum rosae (L.): WA, Yakima Co., Grandview, 25-IX-94, on *Rosa* sp. (94G023).

Myzus cerasi (F.): WA, Benton Co., WSU-Prosser, 27-VI-94, on *Prunus avium* (94K015).

Myzus sp.: WA, Whitman Co., Pullman, 14-IX-93, on *Forsythia* sp. (93T019).

Uroleucon ivae Robinson: WA, Yakima Co., near Grandview, County Line Rd & I-82, 11-VIII-94, on *Iva xanthifolia* (94R094).

Uroleucon russellae (Hille Ris Lambers): WA, Skamania Co., Ice Cave near Trout Lake, 8-IX-94, on *Anaphalis margaritacea* (94R188).

Mixed aphids: *Acyrthosiphon latucae* (Passerini) and *Macrosiphum euphorbiae* (Thomas), WA, Yakima Co., near Sunnyside, 16-X-94, on *Lactuca serriola* (94G083). *Chaetosiphon tetrahodum* (Walker), *Fimbriaphis wakibae* (Hottes), *Macrosiphum euphorbiae* (Thomas), WA, Kittitas Co., Lost Lake, 7-VII-94, on *Rosa* sp. (94K045). *Hayhurstia atriplicis* (L.) and *Macrosiphum euphorbiae* (Thomas), WA, Yakima Co., near Sunnyside, 10-X-94, on *Chenopodium album* (94G071). *Hyperomyzus lactucae* (L.) and *Macrosiphum euphorbiae* (Thomas), WA, Benton Co., WSU-Prosser, 20-X-94, on *Sonchus oleraceus* (94G092). *Illinoia rhododendri* (Wilson) and undetermined sp., WA, Yakima Co., Bird Creek Meadows, 8-IX-94, on *Vaccinium* sp. (94R177). *Rhopalosiphum maidis* (Fitch) and *R. padi* (L.), WA, Benton Co., Bennett Springs, 4-X-94, on *Echinochloa crus-galli* (94G066). *Sitobion clydesmithi* Robinson and *Sitobion* sp., WA, Skamania Co., Pinto Rock, 25-IX-94, on *Pteridium aquilinum* (94G022).

Undetermined aphid: MT, Sanders Co., Thompson Pass, 27-VII-94, on *Senecio* sp. (94R038).

Genus *Trioxys* Haliday

T. cirsii (Curtis)

Drepanosiphum platanoides (Schrank): WA, Benton Co., WSU-Prosser, 17-V-94, on *Acer pseudoplatanus* (94-009) [parasitoid European in origin, new record for North America].

T. pallidus (Haliday)

Chromaphis juglandicola (Kaltenbach): WA, Yakima Co., Yakima Arboretum, 3-VI-94, on *Juglans regia* (94-053).

Monelliopsis caryae (Monell): WA, Benton Co., WSU-Prosser, 31-VIII-94, on *Juglans regia* (94R128). WA, Yakima Co., Sunnyside, 25-VII-94 (94K071), and Yakima Arboretum, 7-VII-94, on *Juglans nigra* (94K-020).

Myzocallis sp.: WA, Benton Co., WSU-Prosser, 21-VII-94, on *Quercus rubra* (94R011).

Panaphis juglandis (Goeze): WA, Benton Co., WSU-Prosser, 6-VII-94, on *Juglans regia* (94A001). WA, Yakima Co., Yakima Arboretum, 6-VII-94, on *Juglans regia* (94K021).

***T. rosae* Pike & Starý, new species**
(Figs. 25–32)

Diagnosis.—A combination of features characterize the new species: propodeum smooth, but with divergent carinae in lower portion; antenna 11-segmented; Rs vein of forewing short, about equal to stigma width; distal abscissa of R1 short, equal to ⅓ stigma length; prongs, associated with genitalia, almost straight, with 5 nearly perpendicular setae on upper margin and two dilated setae or bristles at apex. The new species keys to *T. infrequens* Smith in Smith (1944), but differs in the shape of its prongs and metasomal tergum 1. Another species, *T. exareolatus* Viereck (1917), reported from Connecticut and attacking the same host as the new species, differs from *T. rosae* in the number, length, and arrangement of setae on the prongs.

Etymology.—The name of the species is derived from its host aphid, *Macrosiphum rosae* (L.).

Description.—*Female.* Head. Tentorioocular line equal to ⅛ intertentoral line. Malar space equal to ⅐ to ⅙ eye length. Antenna 11-segmented, total length somewhat longer than head, mesosoma, and metasomal tergum 1 together, and widening to apex. Flagellomere 1 (F_1) (Fig. 26) length 3.5× width, setae subequal to its width, without longitudinal placodes. F_2 (Fig. 27) slightly longer and wider than F_1, length somewhat greater than 3× width, setae equal to segment diameter, with 1 longitudinal placode. F_5 (Fig. 28), twice as long as wide, about ⅓ wider than F_2, setae equal to ⅓ its width. F_8 twice as long as wide, wider than F_5.

Mesosoma. Antescutal depression (Fig. 31) smooth, with sparse short setae. Mesonotum with notauli crenulate and distinct in ascendent portion, effaced on disc as indicated by a simple row of sparse long setae. Propodeum (Fig. 29) smooth, divergent cariane in posterior declivity, with sparse setae.

Forewing (Fig. 30). Stigma triangular, length 2.5× width; distal abscissa of R1 short, equal to ⅓ stigma length; Rs vein short, equal to width of stigma; lower marginal setae 3× length of surface setae.

Leg. Hind femur with sparse semierect setae, equal to ⅓ segment diameter.

Metasoma. Tergum 1 (Fig. 25), length about 2× width at spiracles, with sparse setae.

Genitalia (Fig. 32). Prong long, almost straight, slightly arcuate at apex, with two dilated setae at apex, 4–5 nearly perpendicular setae along upper margin (setal length greater than prong width distally, but only about ⅔ prong width basally), 9–10 semierect setae on lower margin (setal length about ⅔ prong width basally, somewhat shorter distally).

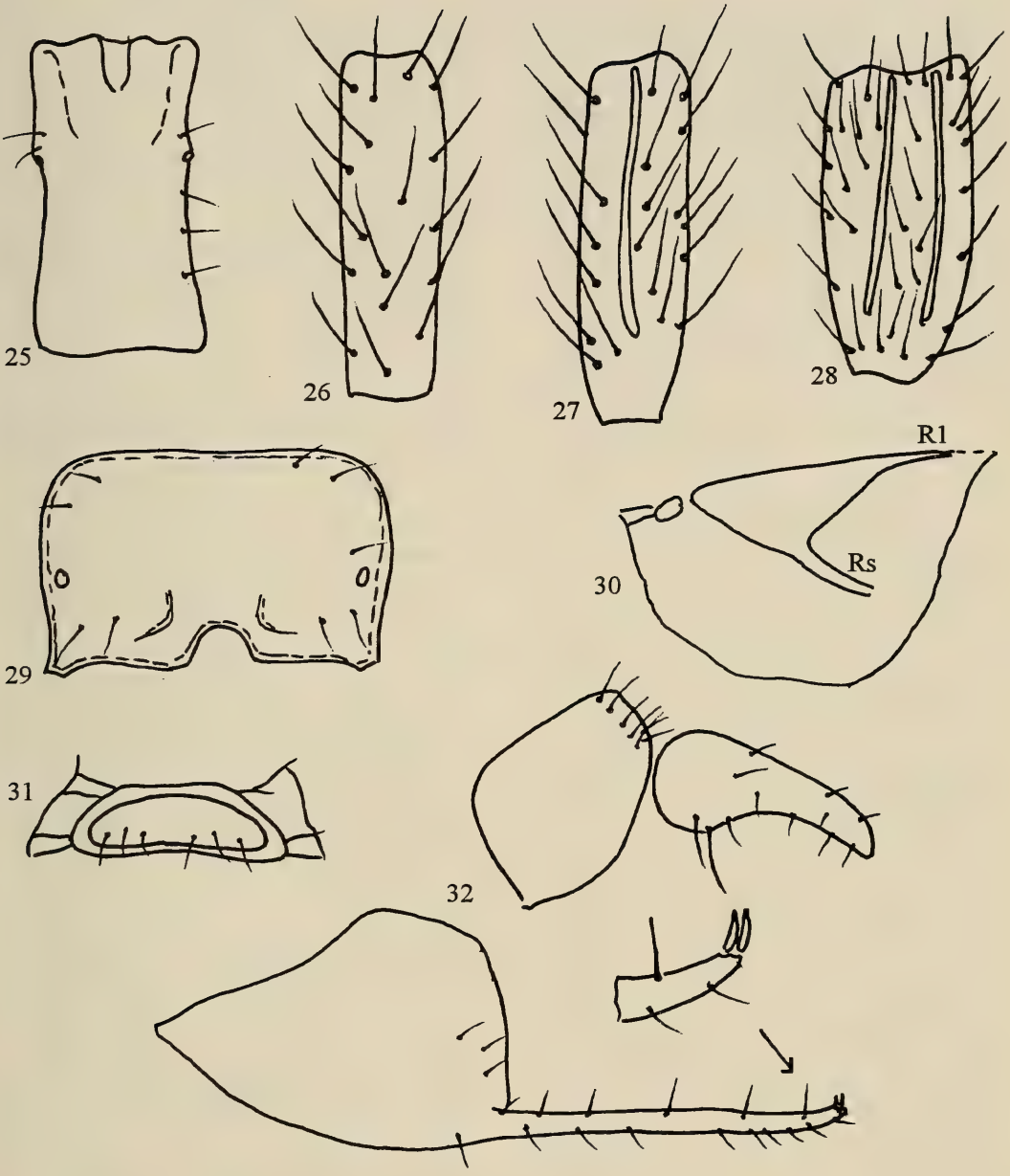
Coloration. Head dark brown. Clypeus brown, palpus light yellow. Antenna brown, excluding yellowish apex of pedicel and narrow base of F_1. Mesosoma dark brown. Wing subhyaline, venation brownish. Tegula brown. Coxa dark brown, trochanter and trochantellus yellow brown; femur and tibia brown; tarsus yellow brown, excluding infuscate apex. Metasoma, centrally brown, basal and apical third yellow brown. Ovipositor sheath and prong brown.

Length of body about 2 mm.

Male. Antenna 13-segmented. Body dark brown. Mouthparts light brown. Apex of pedicel light brown. Legs brown. Mesosoma brown, excluding tergum 1 yellow brown.

Holotype [♀].—USA, WA, Yakima Co., Yakima Arboretum, 3-VI-94, coll. K. Pike & P. Starý. Host: *Macrosiphum rosae* (L.) on *Rosa* sp., sample no. 94-063. Deposited in USNM.

Paratypes.—11 ♀♀, 2 ♂♂ (pinned), same data as holotype. Deposited in part in



Figs. 25-32. *Trioxys rosae,* ♀ paratypes (illustrations not to equal scale). 25, Metasomal tergum 1. 26, Flagellomere 1. 27, Flagellomere 2. 28, Flagellomere 5. 29, Propodeum. 30, Forewing, in part. 31, Antescutal depression. 32, Genitalia. Abbreviations: R1, postmarginal vein; RS, Radial sector.

the Washington State University Collection, James Museum, Pullman, Washington; the Washington State University Collection-Prosser, WA; and the collection of P. Starý, České Budějovicé, Czech Republic.

T. spp.

Aphis coweni Palmer: WA, Kittitas Co., Lost Lake, 7-VII-94, on *Veratrum viride* (94K049).

Pleotrichophorus sp.: WA, Yakima Co., Wiley City, 20-VII-94, on *Haplopappus resinosus* (94R001).

Mixed aphids: *Euceraphis* sp. and *Oestlundiella flava* [Davidson], WA, Skamania Co., Yellow Jacket, 25-IX-94, on *Trautvetteria caroliniensis* (94G021).

Genus Xenostigmus Smith

X. bifasciatus (Ashmead)

Cinara ponderosae (Williams): WA, Yakima Co., Ahtanum Valley, 3-VI-94, on *Pinus ponderosa* (94-065).

Aphid Host–Parasitoid Index

Aphid name
Parasitoid name

Acyrthosiphon lactucae
Ephedrus californicus
Lysiphlebus testaceipes
Praon unicum Smith

Acyrthosiphon pisum
Aphidius ervi
Aphidius smithi
Aphidius sp.
Diaeretiella rapae
Monoctonus sp.
Praon pequodorum
Praon sp.

Aphis armoraciae
Aphidius sp.
Lysiphlebus testaceipes
Praon sp.

Aphis coweni
Ephedrus sp.
Praon unicum
Praon sp.
Trioxys sp.

Aphis helianthi
Lysiphlebus testaceipes
Lysiphlebus sp.

Aphis holodisci
Lysiphlebus testaceipes

Aphis lugentis
Lysiphlebus testaceipes

Aphis neogillettei
Lysiphlebus testaceipes

Aphis neri
Lysiphlebus testaceipes

Aphis pomi
Praon sp.

Aphis rumicis
Lysiphlebus testaceipes
Praon unicum

Aphis salicariae
Binodoxys sp.

Aphis sambuci
Lysiphlebus testaceipes

Aphis spiraecola
Lysiphlebus testaceipes

Aphis varians
Aphidius sp.
Binodoxys carolinensis
Ephedrus sp.
Lysiphlebus testaceipes

***Aphis* sp.**
Aphidius sp.
Lysiphlebus testaceipes
Lysiphlebus sp.
Praon occidentale

Aphthargelia symphoricarpi
Ephedrus californicus
Lysiphlebus testaceipes
Praon sp.

Brachycaudus cardui
Lysiphlebus testaceipes

Brachycaudus helichrysi
Aphidius matricariae
Lysiphlebus testaceipes

Brachycaudus tragopogonis
Lysiphlebus testaceipes
Lysiphlebus sp.

Brachycorynella asparagi
Diaeretiella rapae
Lysiphlebus testaceipes

Braggia eriogoni
Lysiphlebus testaceipes

***Braggia* sp.**
Diaeretiella rapae
Lysiphlebus testaceipes

Brevicoryne brassicae
Aphidius ervi
Diaeretiella rapae

Cedoaphis incognita
Lysiphlebus flavidus
Ceruraphis viburnicola
Praon sp.
Chaetosiphon fragaefolii
Ephedrus californicus
Praon sp.
Chaitophorus populicola
Adialytus salicaphis
Chaitophorus utahensis
Adialytus salicaphis
***Chaitophorus* sp.**
Adialytus salicaphis
Chromaphis juglandicola
Trioxys pallidus
Cinara pilicornis
Pauesia juniperaphidis
Cinara ponderosae
Pauesia ahtanumensis
Pauesia pahtonis
Pauesia ponderosaecola
Xenostigmus bifasciatus
Cinara pseudotaxifoliae
Pauesia pseudotsugae
Cinara pseudotsugae
Pauesia sp.
Diuraphis noxia
Aphidius ervi
Aphidius sp.
Diaeretiella rapae
Lysiphlebus testaceipes
Monoctonus washingtonensis
Praon occidentale
Praon unicum
Praon yakimanum
Drepanosiphum platanoides
Trioxys cirsii
Eoessigia longicauda
Aphidius sp.
Praon sp.
***Euceraphis* sp.**
Trioxys sp.
Hayhurstia atriplicis
Diaeretiella rapae
***Hyperomyzus* sp.**
Aphidius sp.
Praon sp.
Illinoia rhododendri
Aphidius sp.
Binodoxys sp.
Monoctonus sp.
Praon sp.
***Illinoia* sp.**
Aphidius sp.
Monoctonus sp.
Praon occidentale
Kakimia aquilegiae
Aphidius kakimiaphidis
Kakimia cynosbati
Aphidius kakimiaphidis
***Kakimia* sp.**
Aphidius kakimiaphidis
Aphidius sp.
Liosomaphis berberdis
Aphidius hortensis
Macrosiphoniella ludovicianae
Aphidius ohioensis
Macrosiphum albifrons
Aphidius lupini
Macrosiphum californicum
Aphidius sp.
Macrosiphum euphorbiae
Aphidius polygonaphis
Diaeretiella rapae
Ephedrus californicus
Lysiphlebus testaceipes
Praon unicum
Macrosiphum rosae
Ephedrus californicus
Praon occidentale
Praon sp.
Trioxys rosae
***Macrosiphum* sp.**
Diaeretiella rapae
Metopolophium dirhodum
Aphidius sp.
Monoctonus sp.
Monelliopsis caryae
Trioxys pallidus
***Myzocallis* sp.**
Trioxys pallidus
Myzus ascalonicus
Lysiphlebus testaceipes
Myzus cerasi
Praon sp.
Myzus persicae
Diaeretiella rapae

***Myzus* sp.**
Aphidius sp.
Diaeretiella rapae
Praon sp.
Nearctaphis clydesmithi
Lysiphlebus testaceipes
Oestlundiella flava
Trioxys sp.
Panaphis juglandis
Trioxys pallidus
Periphyllus lyropictus
Euaphidius setiger
***Periphyllus* sp.**
Adialytus salicaphis
Phorodon humuli
Aphidius matricariae
Binodoxys conei
Diaeretiella rapae
Lysiphlebus testaceipes
***Pleotrichophorus* sp.**
Trioxys sp.
Pterocomma bicolor
Euaphidius cingulatus
***Pterocomma* sp.**
Euaphidius cingulatus
Rhopalosiphum maidis
Diaeretiella rapae
Lysiphlebus testaceipes
Praon unicum
Rhopalosiphum padi
Aphidius ervi
Diaeretiella rapae
Lysiphlebus testaceipes
Monoctonus washingtonensis
Praon occidentale
Praon unicum
Praon yakimanum
Sipha elegans
Adialytus ambiguus
***Sipha* sp.**
Adialytus ambiguus
Sitobion avenae
Aphidius avenaphis
Aphidius ervi
Aphidius sp.
Diaeretiella rapae
Lysiphlebus testaceipes
Therioaphis trifolii
Praon exsoletum
Uroleucon cirsii
Lysiphlebus testaceipes
Uroleucon ivae
Aphidius ohioensis
Aphidius sp.
Praon pequodorum
Praon sp.
Uroleucon russellae
Ephedrus californicus
Praon sp.
***Uroleucon* sp.**
Aphidius ohioensis
Ephedrus californicus
Ephedrus sp.
Praon occidentale
Utamphorophora humboldti
Aphidius sp.
Mixed aphid colonies:
Acyrthosiphon lactucae/Macrosiphum euphorbiae
Praon sp.
***Aphis helianthi/A.* nr. *varians/A.* sp.**
Binodoxys grafi
Hyperomyzus lactucae/Macrosiphum euphorbiae
Praon sp.
Hyperomyzus lactucae/Uroleucon sonchi
Aphidius sp.
***Illinoia rhododendri*/undetermined sp.**
Ephedrus sp., *Praon* sp.
Obtusicauda coweni/Zyxaphis oregonensis
Binodoxys clydesmithi
***Sitobion clydesmithi/Sitobion* sp.**
Praon sp.

Discussion

The above results constitute a beginning faunistic baseline. Of the total aphidiines discovered, at least five (*Aphidius colemani, Aphidius ervi, Praon exsoletum, Trioxys cirsii,* and *Trioxys pallidus*) represent purposely or accidentally introduced species or species not originally part of the Nearctic fauna. *Trioxys cirsii,* a European species, was recorded for the first time in North America. Secondary adaptation or adaptation of the indigenous parasitoids to new or introduced aphids was common. For example, *Diuraphis noxia,* first detected in

1987 in Washington (Pike et al. 1991), was attacked by more than a half a dozen indigenous species.

The number of aphid-parasitoid genera and species now recognized in the Pacific Northwest is much higher than previously known (Marsh 1979). Ten new species have been described from Washington since 1994 (see also Pike and Starý 1995a, 1995b, 1996). The cumulative parasitoid-aphid-plant information, obtained from varied environments, in part, illustrates the biological characteristics and interlinkage associations of the species, and provides a basis for further studies into biosystematics, species succession, host regulation and biological pest control. These data on parasitoid × host and host-habitat relationships expand not only the knowledge base on population structure, but also help to define the movement and activity of the parasitoids within and between crops and noncrop environments.

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HANSONIA, A NEW GENUS OF CARDIOCHILINE BRACONIDAE (HYMENOPTERA) FROM COSTA RICA, WITH NOTES ON ITS BIOLOGY

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Abstract.—***Hansonia chavarriai* Dangerfield, n. gen, n. sp.,** is described from specimens reared from the apatelodid moth *Hygrochroa firmiana* (Stoll) in the dry forest of the Guanacaste Conservation Area in northwestern Costa Rica. Its relationship to other cardiochiline genera is discussed, as is the available information concerning its biology.

Key Words: Braconidae, Cardiochilinae, parasitoid, Lepidoptera, Apatelodidae

As part of an inventory of the Lepidoptera larvae and their parasitoids in the tropical dry forest of the Guanacaste Conservation Area in northwestern Costa Rica (Janzen 1984, 1987, 1988, 1993; Gauld and Janzen 1994; Sharkey and Janzen 1995), an unusual cardiochiline braconid wasp species was reared from field-collected apatelodid larvae. Ongoing revisionary studies on the genera of Cardiochilinae by the senior author (including Whitfield and Dangerfield, in press) clarified that this species represents a genus new to science. Studies by two of the other authors had come independently to the same conclusion based on unreared specimens; thus we have combined efforts in this multiauthored report.

Below we provide a description of the new genus and species, along with notes on what is currently known of its biology. The biology of the subfamily as a whole in Costa Rica is reviewed by Shaw (1995); the subfamily Cardiochilinae can be keyed using either Shaw (1995) or Wahl and Sharkey (1993). Morphological terminology largely follows that used in Huber and Sharkey (1993), except some features of the wing venation, for which the reader is referred to Wharton and Marsh (in press). The descriptions of the new genus and species should be attributed to the senior author.

Description

Hansonia Dangerfield, New Genus

Type Species: *Hansonia chavarriai* Dangerfield, new species.

Generic diagnosis.—Among the world genera of Cardiochilinae, *Hansonia* might be most easily confused with species of *Bohayella* Belokobylskij, *Retusigaster* Dangerfield, Austin and Whitfield and *Brevicardiochiles* Dangerfield, Austin and Whitfield. It resembles *Bohayella* in its unusual elongate first metasomal tergite, but differs in having two apical clypeal tubercles and weakly decurved to straight ovipositor sheaths. From *Retusigaster* and *Brevicar-*

diochiles it differs in having all three of the above mentioned characters. The only other New World cardiochiline genus that possesses similarly short ovipositors and evenly sclerotized hypopygia is *Toxoneuron* Say, from which it differs by the two apical clypeal tubercles, the narrow first metasomal tergite and in the cup-like apical projection of the hind tibia in *Toxoneuron.*

The known distribution of *Hansonia* is from Jalisco, Mexico (based on questionable conspecific material seen by IM), south to Costa Rica.

Hansonia chavarriai Dangerfield, New Species

(Figs. 1–4)

Description.—Body. Medium-sized, pale yellow with black markings, relatively smooth; evenly infuscate wings with yellow venation.

Head. Eyes with reduced pilosity represented as sparse minute interommatidial spines; two clypeal tubercles present; head visible surrounding eyes in anterior view; clypeus 2.4–2.7× as broad as high; face 2.0× as broad as high; eye : temple ratio 1 : 1.0–1 : 1.2; malar carina absent; glossa short, weakly bilobed at apex; galea short and broad; maxillary palp six-segmented, the basal segment reduced to a weakly-sclerotized plate; mandible bidentate; occiput 0.25–0.4× as deep as length of head; antennae separated by 0.7–0.85× width of antennal socket; antenna with 48 flagellomeres; scape 1.6–1.7× as long as broad.

Mesosoma. Notauli crenulate, well-defined, meeting posteriorly; medial scutum smooth; scutellar sulcus relatively broad, 1.9–2.7× as broad as long; apical scutellar cup absent; lateral lobes of scutellum smooth; propodeal areola appears complete, but is composed of lateral carinae which do not meet anteriorly but continue to the anterior margin of the propodeum; propodeum without medial longitudinal furrow, but with faint medial longitudinal carina present; epicnemial carina absent.

Legs. Hind tibia with slight apical projection, non cup-like; hind basitarsus slightly flattened basally but mostly cylindrical in cross-section; tarsal claws evenly pectinate.

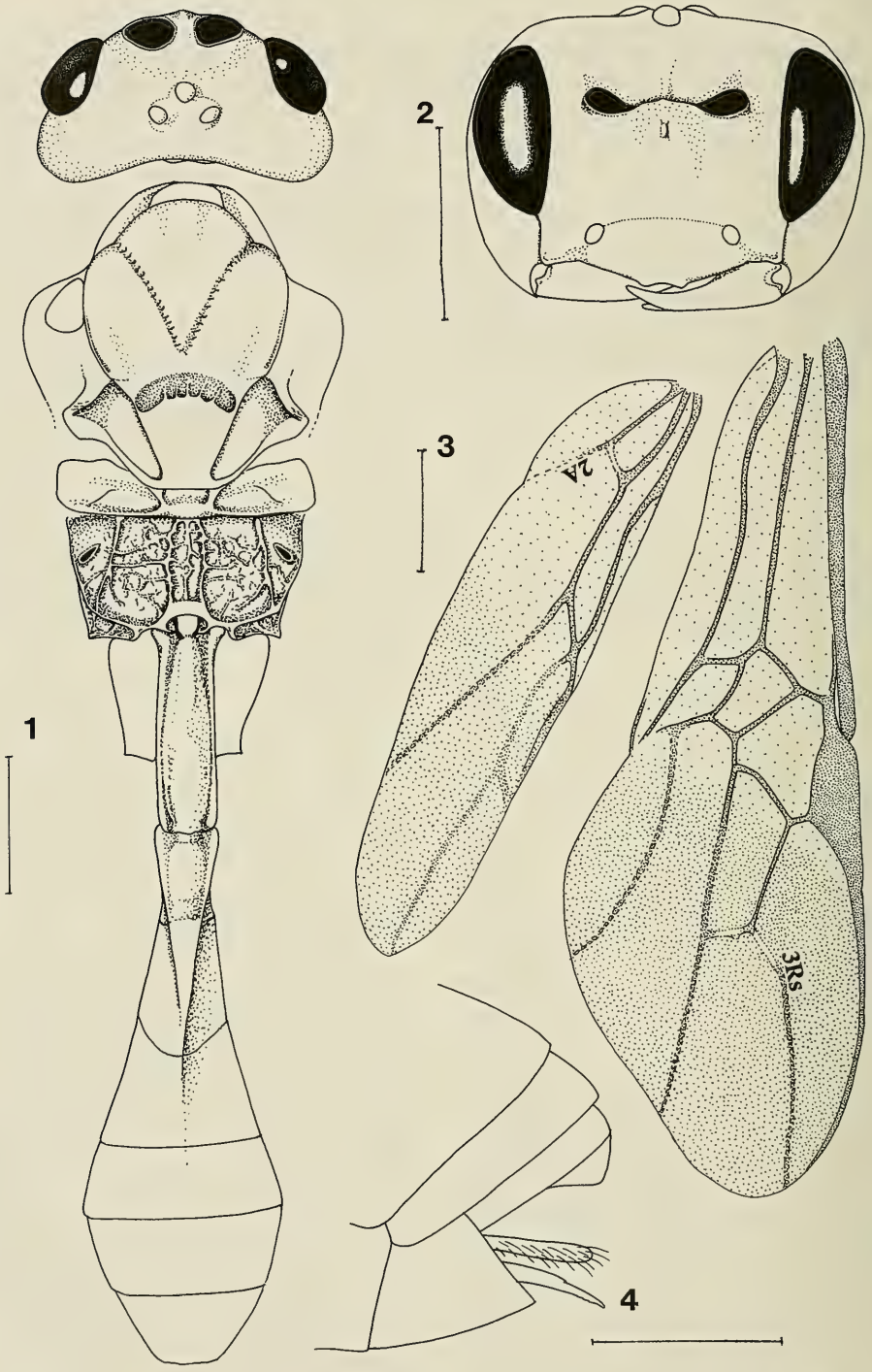
Wings. Fore wing with 1r absent, 3r absent, discal cell elongate, stigma 3.3–4.0× as long as wide, 3Rs with 135° angle 0.2× along length from base; hind wing with 2r–m absent, 2A present in basal one fifth, 7 hamuli present.

Metasoma. T1 3.5–4.0× as long as broad; median field of T2 2.2× as long as broad; laterotergites of T1–T3 at right angles to tergites giving the metasoma an anteriorly compressed or petiolate appearance in dorsal view; ovipositor sheaths evenly setose, 0.18–2.0× as long as hind tibia, 0.25× as broad as long, weakly decurved to straight along length; hypopygium acutely pointed at apex, evenly sclerotised throughout.

Holotype.—**Costa Rica:** 1 female, Guanacaste Province, Guanacaste Conservation Area, Sector Santa Rosa, Rio Cuajiniquil (N10°53′, W85°37′), D. H. Janzen and W. Hallwachs, voucher specimen database (93-SRNP-2988) (see "Host" and "Biology" sections below for further information associated with this voucher number). Deposited at INBio, Costa Rica.

Paratypes.—**Costa Rica:** 2 females, Guanacaste Province, Guanacaste Conservation Area, Sector Santa Rosa, Sendero Natural (N10°51′, W85°37′), 26 June 1977, Malaise trap, D. H. Janzen; 2 females, Guanacaste Province, Guanacaste Conservation Area, Sector Santa Rosa, Sendero Natural (N10°51′, W85°37′), 28 May 1978, Malaise trap, D. H. Janzen; 1 female, Guanacaste Province, Santa Rosa National Park, 300 m, Malaise SE-6-C, Bosque San Emilio, deciduous forest 50 yr. old, 5 July 1986, full shade, I.D. Gauld (University of Wyoming). Deposited at INBio, USNM, BMNH, CNCI.

Host.—Hansonia chavarriai has been repeatedly reared from the last instar larvae of *Hygrochroa* (*Apatelodes*) *firmiana* (Stoll) (Apatelodidae).



Figs. 1–4. *Hansonia chavarriai,* female paratype. 1, Dorsal habitus. Anterior head. 3, Fore and hind wings. 4, Lateral view of metasomal apex. Scale lines = 1 mm.

Etymology.—The genus *Hansonia* is named in honor of Paul E. Hanson, Professor of Biology at the University of Costa Rica, in recognition of his intensive and long-term efforts to make the parasitic Hymenoptera of Costa Rica available for study.

Hansonia chavarriai is named in honor of Luis Felipe Chavarria Diaz, in recognition of his diligent pioneering efforts to develop and execute the biodiversity prospecting program for INBio in the Guanacaste Conservation Area.

Biology

The larva of *Hansonia chavarriai* emerges from the last instar larva of *Hygrochroa* (Apatelodes) *firmiana* (Stoll) (Apatelodidae) as it lies on the surface of the litter, where it has fallen after being killed by the larva of the parasitoid. Death of the host larva occurs many days to weeks after oviposition. Only one parasitoid larva develops per caterpillar. The parasitoid larva burrows into the loose surface leaves of the litter, and spins a golden to light brown ovoid cocoon (5–20 mm long and 7–10 mm diameter). The cocoon silk is lightly attached to the leaves by its glue. The outer wall of the cocoon is a thin, loose and baggy irregular layer around the inner wall of the cocoon. The inner wall of the cocoon is extremely tough, about 2 mm thick, hard and has very obvious shallow ridges ("fluting") running the length of the hard inner wall of the cocoon. The inside surface of the inner cocoon wall is extremely hard and polished, almost appearing to be gold foil. The inner cocoon is reminiscent of a gigantic *Microplitis* Foerster (Braconidae: Microgastrinae) cocoon in that it is hard, fluted and ovoid.

The dry forest habitat occupied by *Hansonia chavarriai* has a six month rain-free dry season (December–May, Janzen 1993). Wasp larvae emerge from first generation apatelodid larvae toward the end of the first half of the rainy season (July), spin their cocoons, and remain as dormant larvae or pupae in their cocoons through the remainder of the rainy season, all of the long dry season, and then eclose toward the end of the first month of the next rainy season. This means that they are eclosing about the time that the first generation of their caterpillar hosts are middle- to late-instars (June). *Hygrochroa firmiana* generally has but one generation a year, with the adult moths eclosing at the beginning of the rains (mid- to late May).

All certain rearings of *Hansonia chavarriai* have been from *Hygrochroa firmiana.* Of the 20 *H. firmiana* caterpillars found in the wild in 1978–1995 (from a total of more than 65,000 wild-caught larvae), 85% were parasitized by a single larva of *Hansonia chavarriai.* Nine of these *Hansonia* subsequently were eaten by as yet unidentified perilampid hyperparasitoids and seven died of unknown causes as prepupae or pupae in their cocoons, and the adults are thus unavailable for study. The distinctive cocoon enabled identification of the unemerged material. In two other cases of the total 131 apatelodid caterpillars found (10 species), a large wasp larva that could have been *H. chavarriai* (or *Enicospilus gamezi* Gauld) emerged from another species of apatelodid last instar larva but died without spinning a cocoon.

Hygochroa firmiana eggs are laid in batches of 5–8 and the early instar larvae feed as a small group until the penultimate and ultimate instars, when they separate and go their own way. The caterpillars are covered with a dense coat of 3–4 mm very fine hairs that may be bright white, lemon yellow, bright lavendar or silver gray. Whatever the color-morph of the caterpillar, it is flecked with widely-spaced tiny black dots on the surface of the hairs. Owing to the brightly-colored "fine-haired bottlebrush" appearance of the caterpillars, and their ostentatious behavior of walking around in the daytime on the upper surface of their host plant leaves and branches, it is assumed that they are either chemically toxic (they do not urticate) or Batesian mimics of

similar Megalopygidae caterpillars (which urticate strongly).

Larvae collected as early as the antepenultimate instar have been found to be parasitized by *Hansonia chavarriai* larvae, but it is not known if the wasps also oviposit in later instar larvae. At whatever instar they oviposit, the wasp has to be able to cope with an extremely hairy larva.

The parasitized larva abruptly stops feeding at full size but before it is a prepupa, dies, and falls to the litter. The cream-colored wasp larva emerges through the body wall of the caterpillar 3–5 days later. Were the wasp larva to wait until the caterpillar is a prepupa before killing (consuming) the caterpillar, it would still be emerging into the litter (rather than into a cocoon), because the moth prepupa pupates naked in the litter.

Acknowledgments

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NOMENCLATURAL CHANGES IN THE ERIOCOCCIDAE (HOMOPTERA: COCCOIDEA)

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Abstract.—A catalog of the eriococcid scale insects of the world is nearly complete and will soon be placed on the World Wide Web. Before this is done, new nomenclatural changes need to be validated in print. Therefore, this publication includes 191 new combinations, four replacement names, and one new generic synonym.

Key Words: Felt scales, Coccoidea, Eriococcidae, catalog, new combinations, replacement names

We currently are completing a systematic database and manuscript on the Eriococcidae of the World. It is part of a larger project called ScaleNet to develop a systematic database of the Coccoidea of the World. ScaleNet is funded by the United States–Israel, Binational Agricultural Research and Development Fund (project No. IS-2423-94) and is being undertaken jointly with Yair Ben-Dov, Department of Entomology, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel. The database resides in BASIS a user friendly cataloging system that resides in FoxPro and was developed by Gary Gibson, Eastern Cereals and Oil Seed Research Centre, Agriculture Canada. The database application is Microsoft FoxPro.

The purpose of this paper is to publish all new nomenclatural information that has resulted from our cataloging activities. Because we intend to make the database available through the World Wide Web, it is important that all new information be validated through publication before it is made available via the Internet.

Within the Eriococcidae, the most controversial and variable generic concepts center around the status of *Acanthococcus* Signoret, *Anophococcus* Balachowsky, *Eriococcus* Targioni Tozzetti, *Greenisca* Borchsenius, *Gregoporia* Danzig, *Kaweckia* Koteja and Zak-Ogaza, and *Rhizococcus* Signoret. Hoy (1963) in his catalog of the Eriococcidae of the World treated *Acanthococcus* and *Rhizococcus* as junior synonyms of *Eriococcus,* but considered *Greenisca* to be distinct with *Anophococcus* as a junior synonym. Williams (1985) adhered to Hoy's system but also synonymized *Greenisca* and *Kaweckia.*

Other researchers have continued to recognize the various genera as separate valid entities, e.g. Kosztarab and Kozar (1988). The characters used to distinguish these genera usually involve the distribution of the enlarged setae and the presence and distribution of various kinds of dorsal sessile pores. For example, *Rhizococcus* is characterized by having enlarged setae that are restricted to the body margin, in contrast to *Acathococcus* which has the dorsal enlarged setae scattered over the dorsum. If a careful analysis is made of the species that possess

the characteristics of *Rhizococcus,* it soon becomes evident that it includes an artificial aggregation of species, many of which have independently evolved reduced dorsal enlarged setae, probably in response to ecological factors such as inhabiting a concealed habitat. The same situation is apparently true of the distribution of dorsal multilocular and cruciform pores. For the purposes of the ScaleNet project, we generally have followed the concepts of Hoy and Williams except that *Eriococcus* is restricted to the apparently monophyletic group of species that have unusually large tubular ducts on the head and that *Acanthococcus* contains the remainder of the group. This concept is consistent with the conclusions of Miller and Williams (1976).

Many new combinations are required, because most species within this group have previously been placed in the genus *Eriococcus sensu lato* and are here being transferred to *Acanthococcus.*

Methods

Names are listed with the nomenclatural change in bold face type, followed by remarks (if any), the original combination, author, date, and pagination. In order to avoid using excess space, literature cited includes only those publications that have not previously been included in one of the Coccoidea bibliographies (Morrison and Renk 1957, Morrison and Morrison 1965, Russell et al. 1974, Kosztarab and Kosztarab 1988). In this publication, when an author is cited that has written more than one article in a year, the letter following the date is the same as the letter given in the published bibliography.

New Combinations

***Acanthococcus abdifus* (Hoy), n. comb.**
Eriococcus abditus Hoy, 1962: 32, 34.

***Acanthococcus acericola* (Tang & Hao), n. comb.**
Eriococcus acericola Tang & Hao, 1995: 454.

***Acanthococcus aceris kurdicus* (Bodenheimer), n. comb.**
Eriococcus aceris kurdica Bodenheimer, 1943: 21–22.

***Acanthococcus acutispinatus* (Hoy), n. comb.**
Eriococcus acutispinatus Hoy, 1962: 33, 36.

***Acanthococcus agonis* (Fuller), n. comb.**
Eriococcus agonis Fuller, 1897a: 1345.

***Acanthococcus albatus* (Hoy), n. comb.**
Eriococcus albatus Hoy, 1962: 33, 38.

***Acanthococcus amomidis* (Gomez-Menor), n. comb.**
Eriococcus amomidis Gomez-Menor, 1935: 2152–2153.

***Acanthococcus angulatus* (Froggatt), n. comb.**
Eriococcus angulatus Froggatt, 1916: 426.

***Acanthococcus apiomorphae* (Fuller), n. comb.**
Eriococcus apiomorphae Fuller, 1897a: 1345.

***Acanthococcus araucariae minor* (Maskell), n. comb.**
Eriococcus araucariae minor Maskell, 1895a: 21.

***Acanthococcus araucariae nudus* (Gomez-Menor), n. comb.**
Eriococcus araucariae nuda Gomez-Menor, 1957: 79.

***Acanthococcus arboisi* (Goux), n. comb.**
Eriococcus arboisi Goux, 1991: 46–47.

***Acanthococcus arcanus* (Hoy), n. comb.**
Eriococcus arcanus Hoy, 1962: 15, 32, 42, 204.

***Acanthococcus argentifagi* (Hoy), n. comb.**
Eriococcus argentifagi Hoy, 1962: 31, 44.

***Acanthococcus armeniacus* (Tang & Hao), n. comb.**
Eriococcus armeniacus Tang & Hao, 1995: 456–457.

***Acanthococcus artiguesi* (Goux), n. comb.**
Eriococcus artiguesi Goux, 1991: 48–49.

***Acanthococcus asteliae* (Hoy), n. comb.**
Eriococcus asteliae Hoy, 1962: 32, 46.

***Acanthococcus australis* (Maskell), n. comb.**
Eriococcus buxi australis Maskell, 1895b: 65.
***Acanthococcus bambusae* (Green), n. comb.**
Eriococcus bambusae Green, 1922: 350.
***Acanthococcus beilschmiediae* (Hoy), n. comb.**
Eriococcus beilschmiediae Hoy, 1962: 33, 48.
***Acanthococcus betulaefoliae* (Tang & Hao), n. comb.**
Eriococcus betulaefoliae Tang & Hao, 1995: 460.
***Acanthococcus bezzii* (Leonardi), n. comb.**
Eriococcus bezzii Leonardi, 1907b: 148–151.
***Acanthococcus bicolor* (Froggatt), n. comb.**
Rhizococcus bicolor Froggatt, 1915: 1059.
***Acanthococcus boguschi* (McDaniel), n. comb.**
Eriococcus boguschi McDaniel, 1964: 101.
***Acanthococcus brachypodii* (Borchsenius & Danzig), n. comb.**
Greenisca brachypodii Borchsenius & Danzig, 1966: 43.
***Acanthococcus brasiliensis* (Cockerell), n. comb.**
Eriococcus brasiliensis Cockerell, 1900: 363–364.
***Acanthococcus brevenniae* (Goux), n. comb.**
Eriococcus brevenniae Goux, 1993: 65–69.
***Acanthococcus brittini* (Hoy), n. comb.**
Eriococcus brittini Hoy, 1962: 50.
***Acanthococcus cactearum* (Leonardi), n. comb.**
Eriococcus cactearum Leonardi, 1918: 206–208, 215.
***Acanthococcus campbelli* (Hoy), n. comb.**
Eriococcus campbelli Hoy, 1959: 12.
***Acanthococcus campinensis* (Hempel), n. comb.**
Eriococcus campinensis Hempel, 1937: 5–6.
***Acanthococcus cantium* (Williams), n. comb.**
Eriococcus cantium Williams, 1985i: 363.
***Acanthococcus castanopus* (Tang & Hao), n. comb.**
Eriococcus castanopus Tang & Hao, 1995: 463.
***Acanthococcus casuarinae* (Maskell), n. comb.**
Rhizococcus casuarinae Maskell, 1893: 230.
***Acanthococcus caudatus* (Tang & Hao), n. comb.**
Eriococcus caudatus Tang & Hao, 1995: 463–464.
***Acanthococcus cavellii* (Maskell), n. comb.**
Gossyparia cavellii Maskell, 1890: 147.
***Acanthococcus celmisiae* (Maskell), n. comb.**
Rhizococcus celmisiae Maskell, 1884: 135.
***Acanthococcus chaoticus* (Goux), n. comb.**
Eriococcus chaoticus Goux, 1991: 49–50.
***Acanthococcus chathamensis* (Hoy), n. comb.**
Eriococcus chathamensis Hoy, 1962: 79.
***Acanthococcus chilensis* (Miller & González), n. comb.**
Eriococcus chilensis Miller & González, 1975: 140–142.
***Acanthococcus coffeae* (Hempel), n. comb.**
Eriococcus coffeae Hempel, 1919: 453–457.
***Acanthococcus confluens* (Maskell), n. comb.**
Gossyparia confluens Maskell, 1893b: 227.
***Acanthococcus confusus* (Maskell), n. comb.**
Eriococcus confusus Maskell, 1892: 26.
***Acanthococcus consperus* (Maskell), n. comb.**

Eriococcus consperus Maskell, 1893b: 229–330.

***Acanthococcus constrictus* (Froggatt), n. comb.**

Eriococcus constrictus Froggatt, 1933: 365–367.

***Acanthococcus coprosmae* (Hoy), n. comb.**

Eriococcus coprosmae Hoy, 1962: 32, 60–61.

***Acanthococcus coriaceus* (Maskell), n. comb.**

Eriococcus coriaceus Maskell, 1893b: 229.

***Acanthococcus corniculatus* (Ferris), n. comb.**

Eriococcus corniculatus Ferris, 1950: 7.

***Acanthococcus costaricensis* (Cockerell & Robinson), n. comb.**

Eriococcus costaricensis Cockerell & Robinson, 1915: 105.

***Acanthococcus crenilobatus* (Hoy), n. comb.**

Eriococcus crenilobatus Hoy, 1962: 32, 64.

***Acanthococcus crispus* (Fonscolombe), n. comb.**

Coccus crispus Fonscolombe, 1834: 204.

***Acanthococcus crofti* (Froggatt), n. comb.**

Eriococcus crofti Froggatt, 1916: 430.

***Acanthococcus cultellus* (Hoy), n. comb.**

Eriococcus cultellus Hoy, 1959: 14, 23.

***Acanthococcus curassavicus* (Reyne), n. comb.**

Eriococcus curassavicus Reyne, 1964: 101–114.

***Acanthococcus dacrydii* (Hoy), n. comb.**

Eriococcus dacrydii Hoy, 1962: 32, 66.

***Acanthococcus danthoniae* (Maskell), n. comb.**

Eriococcus danthoniae Maskell, 1891: 21, 22.

***Acanthococcus detectus* (Hoy), n. comb.**

Eriococcus detectus Hoy, 1962: 85.

***Acanthococcus diverspinus* (Leonardi), n. comb.**

Eriococcus diverspinus Leonardi, 1911: 249–251.

***Acanthococcus elaeocarpi* (Hoy), n. comb.**

Eriococcus elaeocarpi Hoy, 1962: 32, 72.

***Acanthococcus elegans* (Fuller), n. comb.**

Eriococcus elegans Fuller, 1897b: 1345.

***Acanthococcus elytranthae* (Hoy), n. comb.**

Eriococcus elytranthae Hoy, 1962: 32, 74, 204.

***Acanthococcus emirnensis* (Mamet), n. comb.**

Eriococcus emirnensis Mamet, 1954: 25–27.

***Acanthococcus ericae* (Signoret), n. comb.**

Eriococcus ericae Signoret, 1875b: 31.

***Acanthococcus etbaicus* (De Lotto), n. comb.**

Eriococcus etbaicus De Lotto, 1954a: 215–216.

***Acanthococcus eucalypti* (Maskell), n. comb.**

Eriococcus eucalypti Maskell, 1892: 27, 28.

***Acanthococcus eurythrix* (Miller & González), n. comb.**

Eriococcus eurythrix Miller & González, 1975: 142–144.

***Acanthococcus evelinae* (Kozar), n. comb.**

Rhizococcus evelinae Kozar, 1983: 144–146.

***Acanthococcus fagicorticis* (Maskell), n. comb.**

Eriococcus fagicorticis Maskell, 1892: 27.

***Acanthococcus festucarum* (Lindinger), n. comb.**

Remarks: *Eriococcus festucarum* was proposed by Lindinger (Lindinger 1932f) as a replacement name for *E. festucae* Kuwana and Fukaya (in Kuwana 1914) which is a junior secondary homonym of *E. festucae* Targioni Tozzetti (1869). *Eriococcus festucae* Kuwana, 1914: 2–3.

***Acanthococcus formicicola* (Newstead), n. comb.**

Eriococcus formicicola Newstead, 1897a: 102.

***Acanthococcus fossilis* (Froggatt), n. comb.**

Eriococcus fossilis Froggatt, 1933: 367.

***Acanthococcus fossor* (Maskell), n. comb.**
Rhizococcus fossor Maskell, 1884: 136–137.

***Acanthococcus franceschinii* (Balachowsky), n. comb.**
Eriococcus franceschinii Balachowsky, 1934b: 98–101.

***Acanthococcus fuligitectus* (Hoy), n. comb.**
Eriococcus fuligitectus Hoy, 1962: 32, 80.

***Acanthococcus gassinus* (Goux), n. comb.**
Eriococcus gassinus Goux, 1992: 41–46.

***Acanthococcus gaultheriae* (Hoy), n. comb.**
Eriococcus gaultheriae Hoy, 1962: 31, 82.

***Acanthococcus gibbus* (Hoy), n. comb.**
Eriococcus gibbus Hoy, 1959: 14.

***Acanthococcus glyceriae* (Green), n. comb.**
Eriococcus glyceriae Green, 1921: 146–148.

***Acanthococcus gouxi* (Balachowsky), n. comb.**
Anophococcus gouxi Balachowsky, 1954a: 61–64.

***Acanthococcus graminicola* (Borchsenius), n. comb.**
Rhizococcus graminicola Borchsenius, 1949: 353, 359, 360.

***Acanthococcus grandis* (Maskell), n. comb.**
Rhizococcus grandis Maskell, 1892: 29–30.

***Acanthococcus grandis spinosior* (Maskell), n. comb.**
Rhizococcus grandis spinosior Maskell, 1893b: 230.

***Acanthococcus guesinus* (Goux), n. comb.**
Eriococcus guesinus Goux, 1992: 41–46.

***Acanthococcus gurneyi* (Fuller), n. comb.**
Eriococcus gurneyi Fuller, 1899: 441.

***Acanthococcus hakeae* (Fuller), n. comb.**
Eriococcus hakeae Fuller, 1897b: 1345.

***Acanthococcus hebes* (Hoy), n. comb.**
Eriococcus hebes Hoy, 1962: 33, 84.

***Acanthococcus hispidus* (Hoy), n. comb.**
Eriococcus hispidus Hoy, 1962: 30, 86.

***Acanthococcus humatus* (Hoy), n. comb.**
Eriococcus humatus Hoy, 1962: 32, 88.

***Acanthococcus iljiniae* (Danzig), n. comb.**
Rhizococcus iljiniae Danzig, 1972c: 339.

***Acanthococcus imperfectus* (Fuller), n. comb.**
Eriococcus imperfectus Fuller, 1897b: 1345.

***Acanthococcus inermis* (Green), n. comb.**
Eriococcus inermis Green, 1915a: 176.

***Acanthococcus ironsidei* (Williams), n. comb.**
Eriococcus ironsidei Williams, 1973a: 83.

***Acanthococcus irregularis* (Froggatt), n. comb.**
Eriococcus irregularis Froggatt, 1921a: 83.

***Acanthococcus istriensis* (Kozar), n. comb.**
Gregoporia istriensis Kozar, 1983b: 142–144.

***Acanthococcus jorgenseni* (Morrison), n. comb.**
Eriococcus jorgenseni Morrison, 1919: 69, 73–74.

***Acanthococcus kamahi* (Hoy), n. comb.**
Eriococcus kamahi Hoy, 1958: 196.

***Acanthococcus kijabensis* (James), n. comb.**
Eriococcus kijabensis James, 1934a: 270–272.

***Acanthococcus kondarensis* (Borchsenius), n. comb.**
Rhizococcus kondarensis Borchsenius, 1949: 57, 58, 353–354.

***Acanthococcus kowhai* (Hoy), n. comb.**
Eriococcus kowhai Hoy, 1962: 32, 92.

***Acanthococcus laeticoris* (Tereznikova), n. comb.**
Greenisca laeticoris Tereznikova, 1965: 975.

***Acanthococcus lanatus* (Hempel), n. comb.**
Eriococcus lanatus Hempel, 1932: 317–318.

***Acanthococcus latilobatus* (Hoy), n. comb.**

Eriococcus latilobatus Hoy, 1962: 31, 94.

***Acanthococcus lecanioides* (Green), n. comb.**

Rhizococcus lecanioides Green, 1915d: 47.

***Acanthococcus leguminicola* (Morrison), n. comb.**

Eriococcus leguminicola Morrison, 1919: 71–73.

***Acanthococcus leptospermi* (Maskell), n. comb.**

Eriococcus leptospermi Maskell, 1891: 22–23.

***Acanthococcus lidgetti* (Cockerell), n. comb.**

Rhizococcus lidgetti Cockerell, 1899k: 88–89.

***Acanthococcus mancus* (Maskell), n. comb.**

Rhizococcus casuarinae mancus Maskell, 1897: 316.

***Acanthococcus maskelli* (Hoy), n. comb.**

Eriococcus maskelli Hoy, 1962: 31, 98.

***Acanthococcus matai* (Hoy), n. comb.**

Eriococcus matai Hoy, 1962: 32, 100.

***Acanthococcus mendozae* (Morrison), n. comb.**

Eriococcus mendozae Morrison, 1919: 68–70.

***Acanthococcus meridianus* (Hoy), n. comb.**

Eriococcus meridianus Hoy, 1962: 32, 102.

***Acanthococcus milleri* (Hoy), n. comb.**

Eriococcus milleri Hoy, 1962: 18–19.

***Acanthococcus mimus* (Hoy), n. comb.**

Eriococcus mimus Hoy, 1962: 33, 104.

***Acanthococcus montanus* (Hoy), n. comb.**

Eriococcus montanus Hoy, 1962: 33, 106.

***Acanthococcus montifagi* (Hoy), n. comb.**

Eriococcus montifagi Hoy, 1962: 31, 108.

***Acanthococcus multispinatus* (Tang & Hao), n. comb.**

Rhizococcus multispinatus Tang & Hao, 1995: 598–599.

***Acanthococcus multispinosus* (Kuhlgatz), n. comb.**

Rhizococcus multispinosus Kuhlgatz, 1898: 185–186.

***Acanthococcus myrsinae* (Hoy), n. comb.**

Eriococcus myrsinae Hoy, 1962: 32, 112.

***Acanthococcus navarinoensis* (Hoy), n. comb.**

Eriococcus navarinoensis Hoy, 1962a: 510.

***Acanthococcus nelsonensis* (Hoy), n. comb.**

Eriococcus nelsonensis Hoy, 1962: 31, 114.

***Acanthococcus nematosphaerus* (Hu, Xie & Yan), n. comb.**

Eriococcus nematosphaerus Hu, Xie & Yan, 1981: 75.

***Acanthococcus neomyrti* (Hoy), n. comb.**

Eriococcus neomyrti Hoy, 1962: 116.

***Acanthococcus ningxianensis* (Tang & Hao), n. comb.**

Eriococcus ningxianensis Tang & Hao, 1995: 481–482.

***Acanthococcus nitidulus* (Hoy), n. comb.**

Eriococcus nitidulus Hoy, 1962: 31, 118.

***Acanthococcus nothofagi* (Hoy), n. comb.**

Eriococcus nothofagi Hoy, 1962: 31, 120.

***Acanthococcus nuerae* (Green), n. comb.**

Eriococcus nuerae Green, 1922: 347, 349.

***Acanthococcus oblongus* (Borchsenius), n. comb.**

Rhizococcus oblongus Borchsenius, 1949: 54, 56, 353, 358.

***Acanthococcus oligacanthus* (Danzig), n. comb.**

Rhizococcus oligacanthus Danzig, 1972c: 341.

***Acanthococcus orariensis* (Hoy), n. comb.**

Eriococcus orariensis Hoy, 1954: 465–474.

***Acanthococcus orientalis* (Borchsenius), n. comb.**

Greenisca orientalis Borchsenius, 1956b: 676, 677, 679.

***Acanthococcus pallidus* (Maskell), n. comb.**

Eriococcus pallidus Maskell, 1885a: 29, 30.

***Acanthococcus papillosus* (Morrison), n. comb.**
Eriococcus papillosus Morrison, 1924a: 145–147.
***Acanthococcus parabilis* (Hoy), n. comb.**
Eriococcus parabilis Hoy, 1962: 32, 126–127, 200.
***Acanthococcus parvisetus* (Lindinger), n. comb.**
Eriococcus parvispinus Goux, 1948: 5–6.
***Acanthococcus parvulus* (Hoy), n. comb.**
Eriococcus parvulus Hoy, 1962: 31, 128.
***Acanthococcus perplexus* (Hempel), n. comb.**
Eriococcus perplexus Hempel, 1900a: 381–382.
***Acanthococcus philippinensis* (Morrison), n. comb.**
Rhizococcus philippinensis Morrison, 1920: 161–164.
***Acanthococcus phyllocladi* (Maskell), n. comb.**
Eriococcus phyllocladi Maskell, 1892: 25.
***Acanthococcus picta* (Froggatt), n. comb.**
Eriococcus picta Froggatt, 1916: 573.
***Acanthococcus pimeliae* (Hoy), n. comb.**
Eriococcus pimeliae Hoy, 1963: 31, 132–133.
***Acanthococcus piptandeniae* (Hempel), n. comb.**
Eriococcus piptandeniae Hempel, 1937: 6–8.
***Acanthococcus placidus* (Green), n. comb.**
Eriococcus placidus Green, 1921: 148–149.
***Acanthococcus podocarpi* (Hoy), n. comb.**
Eriococcus podocarpi Hoy, 1962: 31, 134, 198, 206.
***Acanthococcus pohutukawa* (Hoy), n. comb.**
Eriococcus pohutukawa Hoy, 1958: 179, 193, 199.
***Acanthococcus popayanensis* (Balachowsky), n. comb.**
Eriococcus popayanensis Balachowsky, 1959a: 365–366.
***Acanthococcus pseudinsignis* (Green), n. comb.**
Eriococcus pseudinsignis Green, 1921: 149–150.
***Acanthococcus pustulatus* (Maskell), n. comb.**
Rhizococcus pustulatus Maskell, 1893b: 231.
***Acanthococcus puymorensis* (Goux), n. comb.**
Eriococcus puymorensis Goux, 1992: 41–46.
***Acanthococcus raithbyi* (Maskell), n. comb.**
Eriococcus raithbyi Maskell, 1890: 145–146.
***Acanthococcus rata* (Hoy), n. comb.**
Eriococcus rata Hoy, 1958: 191–193.
***Acanthococcus reynei* (Schmutterer), n. comb.**
Eriococcus reynei Schmutterer, 1952: 378, 413, 414–417.
***Acanthococcus rhadinothrix* (Miller & González), n. comb.**
Eriococcus rhadinothrix Miller & González, 1975: 146–147.
***Acanthococcus rhodomyrti* (Green), n. comb.**
Eriococcus rhodomyrti Green, 1922: 352.
***Acanthococcus rosaceus* (Balachowsky), n. comb.**
Eriococcus rosaceus Balachowsky, 1932e: 233–234.
***Acanthococcus rosannae* (Tranfaglia & Esposito), n. comb.**
Eriococcus rosannae Tranfaglia & Esposito, 1985: 130–132.
***Acanthococcus rotundus* (Hoy), n. comb.**
Eriococcus rotundus Hoy, 1962: 31, 42.
***Acanthococcus rubrus* (Matesova), n. comb.**
Greenisca rubra Matesova, 1960a: 205, 209–212.
***Acanthococcus rubrifagi* (Hoy), n. comb.**
Eriococcus rubrifagi Hoy, 1962: 31, 144.
***Acanthococcus rugosus* (Froggatt), n. comb.**
Eriococcus rugosus Froggatt, 1933: 367–368.
***Acanthococcus rusapiensis* (Hall), n. comb.**

Eriococcus rusapiensis Hall, 1937: 124–125.

***Acanthococcus saboteneus* (Kuwana & Tanaka), n. comb.**
Eriococcus saboteneus Kuwana & Tanaka, 1922: 215–221.

***Acanthococcus sachalinensis* (Siraiwa), n. comb.**
Eriococcus sachalinensis Siraiwa, 1939: 65–66.

***Acanthococcus salsolae* (Borchsenius), n. comb.**
Rhizococcus salsolae Borchsenius, 1949: 53, 56, 353, 363.

***Acanthococcus sanguinairensis* (Goux), n. comb.**
Eriococcus sanguinairensis Goux, 1993: 68–69.

***Acanthococcus serratilobis prominens* (Green), n. comb.**
Eriococcus serratilobis prominens Green, 1915d: 46.

***Acanthococcus serratilobis serratilobis* (Green), n. comb.**
Eriococcus serratilobis Green, 1915d: 45.

***Acanthococcus setulosus* (Hoy), n. comb.**
Eriococcus setulosus Hoy, 1962: 115.

***Acanthococcus simplex* (Maskell), n. comb.**
Eriococcus simplex Maskell, 1897: 317.

***Acanthococcus socialis* (Goux), n. comb.**
Eriococcus socialis Goux, 1931a: 63, 64–67.

***Acanthococcus sophorae* (Green), n. comb.**
Eriococcus sophorae Green, 1929: 375.

***Acanthococcus sordidus* (Green), n. comb.**
Eriocococcus sordidus Green, 1904: 68.

***Acanthococcus spiniger* (Maskell), n. comb.**
Eriococcus spiniger Maskell, 1896b: 398.

***Acanthococcus stenoclini* (Mamet), n. comb.**
Eriococcus stenoclini Mamet, 1950: 18, 21, 26–28.

***Acanthococcus sutepensis* (Takahashi), n. comb.**
Eriococcus sutepensis Takahashi, 1942b: 8–10.

***Acanthococcus targassonensis* (Goux), n. comb.**
Eriococcus targassonensis Goux, 1993: 67–69.

***Acanthococcus tavignani* (Goux), n. comb.**
Eriococcus tavignani Goux, 1991: 46.

***Acanthococcus tenuis* (Green), n. comb.**
Eriococcus tenuis Green, 1922: 351, 352.

***Acanthococcus tepperi* (Maskell), n. comb.**
Eriococcus tepperi Maskell, 1892: 29.

***Acanthococcus tesselatus* (Froggatt), n. comb.**
Eriococcus tesselatus Froggatt, 1916: 576.

***Acanthococcus tholothrix* (Miller & González), n. comb.**
Eriococcus tholothrix Miller & González, 1975: 146–149.

***Acanthococcus thymi* (Schrank), n. comb.**
Coccus thymi Schrank, 1801: 146.

***Acanthococcus timidus* (Hulden), n. comb.**
Eriococcus timidus Hulden, 1985: 59–61.

***Acanthococcus tricarinatus* (Fuller), n. comb.**
Eriococcus tricarinatus Fuller, 1897b: 1345.

***Acanthococcus tripartitus* (Fuller), n. comb.**
Rhizococcus tripartitus Fuller, 1897b: 1345.

***Acanthococcus trispinatus* (Wang), n. comb.**
Eriococcus trispinatus Wang, 1974: 329–333.

***Acanthococcus tucurincae* (Laing), n. comb.**
Eriococcus tucurincae Laing, 1929a: 467–469.

***Acanthococcus valenzuelae* (Balachowsky), n. comb.**
Eriococcus valenzuelae Balachowsky, 1959a: 363–465.

***Acanthococcus variabilis* (Goux), n. comb.**

Eriococcus variabilis Goux, 1940: 62–65.

***Acanthococcus veyrensis* (Goux), n. comb.**

Eriococcus veyrensis Goux, 1991: 47–48.

***Acanthococcus villosus* (Froggatt), n. comb.**

Eriococcus villosus Froggatt, 1916: 577.

***Acanthococcus zygophylli* (Archangelskaya), n. comb.**

Eriococcus zygophylli Archangelskaya, 1931: 72–73.

Replacement Names

***Acanthococcus danzigae* Miller and Gimpel, n. name.**

Remarks: *Acanthococcus danzigae* is a replacement name for *A. confusus* Danzig (1962a) which is a junior secondary homonym of *A. confusus* Maskell (1892).

Rhizococcus confusus Danzig, 1962a: 854.

***Acanthococcus dziedzickae* Miller and Gimpel, n. name**

Remarks: *Acanthococcus dziedzickae* is a replacement name for *Acathococcus palustris* (Dziedzicka & Koteja) (1971) which is a junior secondary homonym of *A. palustris* Dodds (1923).

Rhizococcus palustris Dzeidzicka & Koteja, 1971: 573.

***Acanthococcus matesovae* Miller and Gimpel, n. name**

Remarks: *Acanthococcus matesovae* is a replacement name for *A. multispinosus* Matesova (1976) which is a junior secondary homonym of *A. multispinosus* Kuhlgatz (1898).

Acanthococcus multispinosus Matesova, 1976: 24–26.

***Acanthococcus wangi* Miller and Gimpel, n. name**

Remarks: *Acanthococcus wangi* is a replacement name for *Eriococcus rugosus* Wang which is a junior primary homonym of *Eriococcus rugosus* Froggatt (1933).

Eriococcus rugosus Wang, 1982c: 441–442.

New Synonymy

***Gregoporia* Danzig, new synonymy**

Remarks: This genus is considered to be a junior subjective synonym of *Acanthococcus* Signoret, 1875b. The diagnostic characters of *Gregoporia* of 8–segmented antennae and dorsal quinquelocular pores are within the range of variation expected within *Acanthococcus.*

Gregoporia Danzig 1979: 46.

Acknowledgments

We are especially grateful to Gary Gibson and Jennifer Read, Agriculture Canada for their extensive assistance and guidance in inputting data into the ScaleNet database. The BASIS cataloging system that they developed and improve is a wonderful tool, without which we would not be able to undertake the ScaleNet project. We thank the following individuals for their comments and suggestions relative to improvements of this manuscript: Yair Ben-Dov, Department of Entomology, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel; Michael E. Schauff and David R. Smith, Systematic Entomology Laboratory, Agricultural Research Service, USDA, c/o National Museum of Natural History, Washington, DC.; and Douglas J. Williams, Department of Entomology, The Natural History Museum, London, UK

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NOTE

Nest and Prey of *Solierella vierecki* (Rohwer) (Hymenoptera: Sphecidae: Larrinae)

Solierella vierecki (Rohwer), known from Colorado, Arizona, and California (Krombein, K.V. 1979. Hymenoptera in America north of Mexico 2: 1635–1638), is probably widely distributed in the deserts of the southwestern U.S. and northern Mexico. On 12 September 1995 at Apache, Cochise Co., AZ, we observed a female of this small larrine wasp as she completed nesting. Her nest was in an open area of horizontal ground surrounded by a diversity of low xeric vegetation that included *Eriogonum, Euphorbia, Gutierrezia, Lepidium, Mentzelia,* and *Solanum.*

The wasp, 4.3 mm long, was first noticed because of her dance-like flight at her nest site. The soil was hard packed, consisting of coarse pebbles in a fine, grayish clay/sand matrix. The burrow was plugged with tiny soil particles and she was removing what remained of the tumulus surrounding the former nest opening. Without pause, over a period of two minutes, she repeatedly landed, picked up a particle of soil, flew forward 5–8 cm from the nest in any direction, and dropped her load while in flight. She flew rapidly at a height of ca 4 cm above the ground. She worked methodically, causing the barely visible spoil heap to disappear, thus obscuring all traces of a nest burrow.

The nest consisted of a single shaft penetrating the ground at a 45° angle and extending to a depth of 2.5 cm. This burrow, completely filled with loose soil particles, ended in a single horizontal cell 0.5 cm long and slightly larger than the 2.0 mm tunnel diameter. Williams (1950. Proceedings of the California Academy of Sciences (4) 26: 355–417) placed *S. vierecki* as the sole member of his Group II, and suggested that it might prey upon short-horned grasshoppers as do members of his Groups I and III. Indeed, the single cell we excavated contained three prey specimens, 4.1–4.8 mm long, of *Eritettix simplex* (Scudder) (Acrididae, Gomphocerinae) the velvet striped grasshopper. The paralyzed nymphs lay on their sides, stacked upon each other. The largest specimen on the bottom, had the cylindrical *S. vierecki* egg, 0.43 mm long, attached to its abdomen near the base of the hind leg. The egg detached from the body when the grasshopper was placed in an alcohol vial.

We thank David A. Nickle, Systematic Entomology Laboratory, U.S. Department of Agriculture, for identifying the grasshopper prey. Also, we are grateful to personnel of the American Museum's Southwestern Research Station, Portal, AZ, for hospitality and laboratory facilities during our field work.

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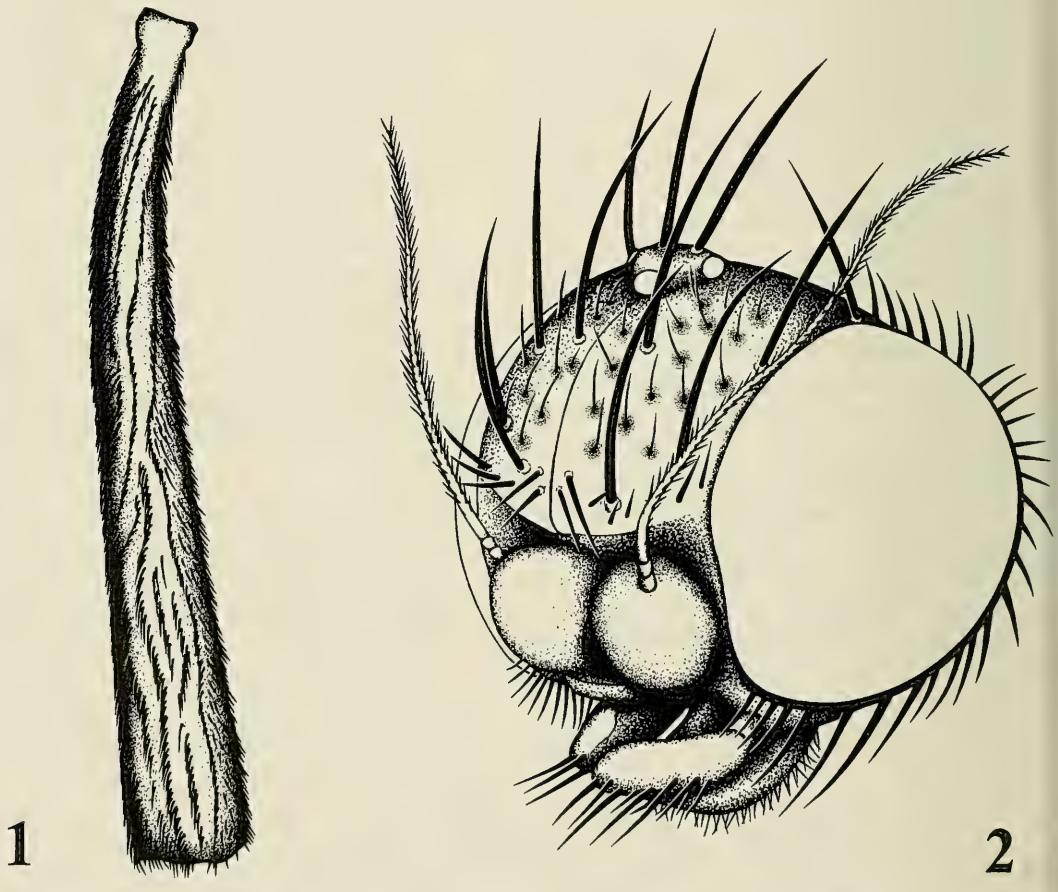
NOTE

First Record of the Genus *Plectanocnema* Schmitz in North America (Diptera: Phoridae)

The phorid fly fauna of North America, reviewed at the generic level (Peterson 1987, *In* Manual of Nearctic Diptera, Vol. 2, pp. 689–712) and the species level (Borgmeier 1963, 1964, 1966. Studia Entomologica, 6: 1–256, 7: 257–416, 8(1965): 1–160) is still insufficiently known. Additions have been noted regularly, and will no doubt continue to accrue (Brown 1988. Canadian Entomologist 120: 307–322; Barnes 1990, 1991. Florida Entomologist, 73: 644–649, 74: 305–310; Brown et al. 1991. Entomologica Scandinavica 22: 241–250).

A new addition to the Nearctic fauna is the genus *Plectanocnema* Schmitz (1926. Encyclopédia Entomologique, Série B. Mémoires et Notes. Diptera. 2(1925): 73–85), with the single known species *P. nudipes* (Becker, 1901. Abhandlungen der Zoologisch-Botanischen Gesellschaft in Wien. 1: 1–100). Three males of this species were collected in coastal British Columbia, Canada. Careful comparison with a male from



Figs. 1–2. *Plectanocnema nudipes,* male. 1, Hind tibia. 2, Head. Illustrations by Jesse Cantley.

the Slovak Republic shows that the genitalia and other characters are identical among the Canadian and European specimens. The collection site is on the campus of Simon Fraser University, and consists of second-growth forest of red alder, cedar, hemlock, douglas fir, and broadleaf maple. Nothing is known about the natural history of these flies.

Specimens of *Plectanocnema* can be identified easily by the multiple longitudinal rows of enlarged setulae on the hind tibia (Fig. 1) and by the distinctive frontal setation (Fig. 2). The most diagnostic characters on the frons are the four divergent supra-antennal setae, and an additional number of enlarged setae placed more laterally.

In the latest key to Nearctic Region phorid genera (Peterson 1987), the divergent supra-antennal setae cause specimens to key out to *Beckerina* at couplet 20. The multiple, longitudinal rows of enlarged setulae on the hind tibia of specimens of *Plectanocnema* differentiates them from specimens of *Beckerina,* which have one or no longitudinal rows.

Material examined.—Specimens are deposited in the Canadian National Collection of Insects (CNC) and the Natural History Museum of Los Angeles County (LACM). CANADA: British Columbia: Burnaby Mountain, 3♂, 26.iv.1979, D.Gillespie (CNC, LACM); SLOVAKIA: Ivanka pri Dunaji, 48.18°N, 17.27°E, 1♂, 27.iv.1992, M.Kozánek, Malaise trap (LACM).

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BYLAWS

The last revision of the Bylaws was published in the Proceedings, vol. 89(3): 625–631, July 1987. Amendments since then were adopted at the regular meetings of February 7, 1991, as noted in the Proceedings, vol. 93(4): 968, October 1991, and February 1, 1996, for which minutes have not yet been published.—*Ad hoc Committee on Bylaws,* David R. Smith and Norman N. Woodley.

BYLAWS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

Article I—Name
Article II—Objectives
Article III—Membership
Article IV—Fees
Article V—Officers
Article VI—Executive Committee
Article VII—Society Committees
Article VIII—Meetings
Article IX—Publications
Article X—Dissolution
Article XI—Limitation and General Prohibitions
Article XII—Amendments

Article I.—Name

The name of this organization is "The Entomological Society of Washington."

Article II.—Objectives

Section 1.—The objectives of the Society are to promote the study of entomology in all its aspects and to cultivate mutually advantageous relations among those in any way interested in entomology. The Society is organized and operated exclusively for scientific and educational purposes.

Article III.—Membership

Section 1.—Membership shall be open to any person with an interest in the science of entomology. Membership shall consist of regular, life, sustaining, emeritus, and honorary members.

Section 2.—Applications for membership shall be made to the Membership Chair in writing. They shall be accompanied by brief statements of qualification and/or interests. The name of each new electee shall be reported by the Membership Chair at a regular meeting; and, in the absence of adverse notice from the members, the electee's name shall be read as a new member at the next regular meeting. If the Membership Chair receives an adverse notice concerning an electee, the candidate's name shall be referred to the Executive Committee and final approval shall be by majority vote of that committee with formal announcement of membership to be made in the usual manner at the next regular meeting following action by the Executive Committee.

Section 3.—Regular members are individuals who pay annual fees to the Society.

Section 4.—Life members are regular members who make a one time contribution of twenty (20) times the current annual fee. Life members are exempt from paying further fees.

Section 5.—Sustaining members are regular members who pay a fee of $750.00 for a 5-year period.

Section 6.—Members of 15 years or more standing, not in arrears for dues or otherwise indebted to the Society when retiring from income-producing employment, may request, and be continued by, the Executive Committee as Emeritus Members without further payment of dues. Members thus relieved of the payment of dues will not be sent copies of the Proceedings.

Section 7.—The Society may elect Honorary Members in recognition of long and meritorious effort to advance entomological science. Individuals so recognized shall be approved unanimously by the Executive Committee and by two-thirds vote of members present at any regular meeting. Honorary Members shall be elected for life, shall pay no fees, and shall be accorded all privileges of members. The number of Honorary Members carried concurrently on the membership roll shall not exceed three, except when an Honorary Member is chosen Honorary President, in which case there may be four.

Section 8.—A membership list shall be published at least once every three years in the Proceedings of the Society.

Article IV.—Fees

Section 1.—The annual fees, which include membership dues and subscription fee, shall be payable by January 1. Annual membership dues shall be $2.00 and the member's subscription rate shall be $23.00. Members residing outside of the United States may be charged a supplement to cover the increased cost of postage; the amount and nature of this supplement to be determined by the Treasurer and approved by the Executive Committee. Members elected prior to June shall receive all numbers of the Proceedings for that year. Members elected after June shall be exempt from fees for the calendar year in which they are elected and shall receive the Proceedings beginning with January of the next year.

Section 2.—The Treasurer shall notify those members one year in arrears for fees. If fees have not been paid one month after notice has been sent, the member's name shall be removed from the mailing list for the Proceedings. The member shall be notified of such action by the Corresponding Secretary. A member who

is two years in arrears for fees maybe dropped from membership by vote of the Executive Committee two months after a final notice has been sent.

Section 3.—A member shall be considered to be one year in arrears if he/she has not paid his/her fees by January of the year in which they are payable.

Section 4.—Members dropped for non-payment of fees, or those who have resigned, may be reinstated by payment of fees for the current year and by payment at membership rate for all copies of the Proceedings for which they are delinquent.

Article V.—Officers

Section 1.—The elected Officers of the Society shall be a President, a President-Elect, a Recording Secretary, a Corresponding Secretary, a Treasurer, an Editor, and Associate Editor, a Custodian, a Program Chair, and a Membership Chair. These shall be chosen from resident members.

Section 2.—The President or, in his/her absence, the senior officer present (as listed in the previous Section) shall preside at all meetings of the Society and of the Executive Committee. The President or his/her substitute shall have authority to and shall appoint any standing or special committees whose services are required in the interests of the Society. He/she shall conduct such correspondence as should appropriately bear his/her signature as presiding officer. He/she shall represent the Society on the Board of Managers of the Washington Academy of Sciences; or he/she may appoint a substitute for him/her. The President shall deliver an address on some subject pertinent to the objectives of the Society at the first or second meeting subsequent to the completion of his/her term of office.

Section 3.—The President-Elect shall automatically succeed to the Presidency at the close of the annual meeting, or whenever the President is unable to completed his/her term of office. He/she shall be responsible for the annual banquet of the Society during the year he/she is President-Elect.

Section 4.—The Recording Secretary shall make a record of the regular Society meetings and meetings of the Executive Committee and shall submit a record of the the regular meetings to the Editor for publication.

Section 5.—The Corresponding Secretary shall conduct all official correspondence of the Society except as otherwise provided, and shall keep a list of all members and their addresses.

Section 6.—The Treasurer shall have charge of and be responsible for all funds and investments of the Society, shall make routine disbursements, shall maintain the mailing list of members and subscribers together with their addresses, and shall be responsible for the mailing of the Proceedings. Unusual disbursements and investments shall be made only at the direction of the Executive Committee. He/she shall collect all sums due to the Society from any source, notify all members and subscribers who are in arrears, and shall present to the Executive Committee an annual report on the financial status of the Society, and conduct such correspondence as is necessary to carry out these duties. The fiscal year of the Society shall be November 1 to the following October 31. The Treasurer shall close his/her books at the end of the fiscal year so the accounts of the Society may be audited prior to its annual meeting.

Section 7.—The Editor shall be responsible for editing all publications of the Society and shall conduct such business as is necessary to carry out this responsibility.

Section 8.—The Associate Editor, who shall automatically succeed to the Editorship, shall normally be elected one year prior to the termination of service by the Editor, which will occur with the completion of a volume of the Proceedings. The Associate Editor shall be responsible for the issues of the nest volume of the Proceedings, which will be entirely his/her responsibility as the incoming Editor.

Section 9.—The Custodian shall have charge of the reserve stock of the Society's publications, shall make such sales as lie within the interests of the Society, and shall be responsible for preserving such records, papers, or items of the Society as shall be deemed necessary by the Executive Committee.

Section 10.—The Program Chair shall be responsible for arranging the program of each meeting of the Society, except for the annual banquet, and for notifying the resident members of the Society of all meetings. Those members living in metropolitan Washington and nearby areas shall be considered resident members.

Section 11.—The Membership Chair shall be responsible for processing applications from prospective members and shall announce the names of the electee(s) at the regular meetings of the Society. He/she shall notify the Corresponding Secretary of the names and addresses of new members, and cooperate with that officer and the Treasurer in maintaining an accurate membership list.

Section 12.—At the annual meeting, having before it the list of candidates submitted by the Nominating Committee, the membership present may make other nominations from the floor. A separate election by written ballot shall be held for each officer for which there are two or more candidates, the ballots being distributed, collected and counted by tellers appointed by the President. When only one candidate for an office is before the Society, election shall be *viva voce* on motion and second from the floor and in that case two or more offices may be treated in one motion.

Section 13.—The officers shall serve for one year and until their successors are elected. They shall assume their duties at the end of the annual (December) meeting except the Treasurer who shall assume his/her

duties as soon as arrangements can readily be made with his/her predecessor and the banks for transfer of Society funds. The Executive Committee may ask for such reports of officers as are deemed necessary. Except for the President and President-Elect, who cannot be reelected to these offices in consecutive years, there shall be no limitation as the the number of terms to which any officer may be elected.

Section 14.—Vacancies in any office except President and President-Elect shall be filled through appointment by the Executive Committee. Members selected to fill such vacancies shall hold office only until their successors are elected. If the office of President-Elect becomes vacant, the position will be filled by a special election in accordance with regular nomination procedures.

Article VI.—Executive Committee

Section 1.—The activities of the Society shall be guided by an Executive Committee. The Committee membership shall consist of all officers and the last available past president.

Section 2.—The Executive Committee shall assume the responsibility for and shall conduct the activities of the Society, direct finances, and provide for meetings and publications. As provided elsewhere in the Bylaws, the Committee shall report fully to the Society once each year, on its conduct of the Society's business, either through the different officers or by a specially approved representative. The report shall include an approved audit of the Treasurer's accounts. The Committee shall also consider and present to the Society proposals for change or improvements, and shall transact all other business requiring attention and not otherwise assigned.

Section 3.—The Executive Committee shall hold such meetings as are required to transact the business of the Society during the year. One of these shall be sufficiently prior to the annual meeting to permit consideration and approval of a summary report for presentation by the President at the annual meeting on the state of the Society and the work of the officers. Other meetings of the Executive Committee may be called at any time by the President or his/her substitute and shall be called promptly by the presiding officer on request of any three members of the Committee other than the presiding officer. The presence of five members of the Executive Committee, six members when there is an Associate Editor, at any meeting shall establish a quorum.

Article VII.—Society Committees

Section 1.—Committees of the Society shall consist of the Publications Committee, Finance Committee, Nominating Committee, and Auditing Committee. New non-elective members of these committees shall be appointed by the incoming President each year. The committees shall report to the Society at one of its meetings or to the Executive Committee as may be required.

Section 2.—The Publications Committee shall consist of the Editor as Chair, the Associate Editor, and at least three appointed members. The appointed members shall assist the Editor. The committee shall consider and put into execution plans for promoting the sales of Society publications. It shall make recommendations to the Executive Committee regarding publication of Memoirs and any other special publication. Terms for appointed members of the Publication Committee shall be at the discretion of the Editor and President.

Section 3.—The Finance Committee, consisting of the Treasurer as Chair, the Editor, the Custodian, and the Program Chair, shall assist the Treasurer in matters of finances of the Society and make recommendations to the Executive Committee relative to these matters. It shall be a particular duty of the Committee to prepare for the Executive Committee at the beginning of each year a statement of the income and expenditures of the preceding year and to prepare a budget based on the estimated receipt and disbursements of the coming year, with such recommendations as seem desirable. No financial obligation against the Society may be contracted by any officer or member except as specified in the annual budget or as provided for by special action of the Executive Committee upon recommendation of the Treasurer and Finance Committee.

Section 4.—The Nominating Committee of three members shall prepare a list of candidates comprising one nominee for each office, except the office of President, for presentation to the membership at the regular meeting one month before the annual meeting. The Committee shall secure the acquiescence of each candidate before presentation.

Section 5.—The Auditing Committee of three persons shall be appointed not later than October of each year. It shall inspect the accounts of the Treasurer and report to the Society at its next annual meeting.

Article VIII.—Meetings

Section 1.—The regular meetings of the Society shall be held, unless otherwise ordered by the vote of the Society or of the Executive Committee, on the first Thursday of each month except July, August, and September. The June meeting is the annual banquet of the Society. The annual meeting for the election of officers shall be the regular meeting for the month of December. Special and field meetings may be called by the Executive Committee. The Program Chair or special committees appointed for special meetings may, with the approval of the Executive Committee, incur reimbursable expenses. Twenty members shall constitute a quorum.

Section 2.—The suggested order of business at the regular meetings, except the annual meeting, shall be as follows:

1. Reading and approval of minutes
2. Reports of officers and committees.
3. Introduction of new members.
4. Miscellaneous business.
5. Presentation of notes and exhibition of specimens.
6. Presentation of announced topics.
7. Introduction of visitors.
8. Adjournment.

Section 3.—The suggested order of business at the annual meeting in December shall be as follows:

1. Reading and approval of minutes.
2. Introduction of new members.
3. Presentation by the President of a summary report on the state of the Society and the work of the retiring officers.
4. Election of new officers.
5. Miscellaneous business.
6. Presentation of notes and exhibition of specimens.
7. Presentation of announced topics.
8. Introduction of visitors.
9. Installation of newly elected President.
10. Adjournment.

Section 4.—Either the first or the second regular meeting following the annual meeting shall be set aside for the delivery of the annual address of the retiring President.

Article IX.—Publications

Section 1.—Publication of the Society shall consist of a periodical to be known as the Proceedings of the Entomological Society of Washington which shall contain the Proceedings of the Society and such papers as are accepted for publication in it, a series of Memoirs, and such miscellaneous handbooks or other special publications as may be deemed desirable. Each member in good standing, except Emeritus Members relieved of payment of fees, is entitled to one copy of each issue of the Proceedings (see Art. IV, Sec. 2).

Section 2.—Financial support of the Proceedings shall be provided from subscription revenues, from the sale of complete or partial sets of the Proceedings, from the fees of life and sustaining memberships, from editorial charges, and from such other funds as the Executive Committee shall determine.

Section 3.—The Society shall maintain a separate fund to be known as the Special Publication Fund. At the discretion of the Executive Committee, any unrestricted portion of the Special Publication Fund may be used for publishing Memoirs, handbooks, or other special publications. In any one year, a sum not exceeding the previous five years' income from interest on the Fund monies may be taken from the Fund and applied toward the publication of the Proceedings, such sum to be returned to the Special Publication Fund at the discretion of the Executive Committee. The Special Publication Fund will be derived from bequests and gifts, from the sale of Memoirs, handbooks, or other special publications, and from such other funds as the Executive Committee shall determine.

Section 4.—The publications of the Society shall be of the highest quality and content. To ensure this the Editor shall require review of all manuscripts before their acceptance for publication.

Article X.—Dissolution

If the Society should be dissolved or terminated, all its assets remaining after payment of all liabilities of the Society shall be transferred by the Executive Committee, upon recommendation of the Executive Committee and approved by the membership of the Society, to one or more nonprofit organizations that have scientific and educational purposes, preferably with the same object as the Society, and that qualify as exempt organizations under Section 501 (c) (3) of the Internal Revenue Code, or under corresponding successor provisions.

Article XI.—Limitation and General Prohibitions

Section 1.—The objectives of the Society are listed in Article II of the Bylaws. Lobbying or activities specifically designed to influence legislation are not among the objectives of the Society and no official group within the Society shall engage in such activity.

Section 2.—Notwithstanding any provision of the Bylaws which might be susceptible to a contrary construction:

a. no part of the net earnings of the Society shall or may under any circumstances inure to the benefit of any private shareholder or individual;
b. no substantial part of the activities of the Society shall consist of carrying on propaganda, (or otherwise attempting to influence legislation);
c. the Society shall not participate in, or intervene in (including the publishing or distributing of statements) political campaigns on behalf of any candidate for public office;
d. the Society shall not be organized or operated for profit;
e. the Society shall not:
    1) lend any part of its income or corpus, without the receipt of adequate security and a reasonable rate of interest, to;
    2) pay any compensation, in excess of a reasonable allowance for salaries or other compensation for personal services actually rendered, to:
    3) make any part of its services available on preferential bases, to;
    4) make any purchase of securities or any other property, for more than adequate consideration in money or money's worth form;
    5) sell any securities or other property for less than adequate consideration in money or money's worth to; or

6) engage in any other transactions which result in substantial diversions of its income or corpus to

any officer, member of the Executive Committee, or substantial contributor to the Society. The prohibitions contained in this subsection (e) do not imply that the Society may make such loans, payments, sales or purchases to anyone else, unless such authority be give or implied by other provisions of the Bylaws.

Article XII.—Amendments

These Bylaws may be amended at any regular meeting by a two-thirds vote of the members voting, if the total number voting represents a quorum, provided that such amendment has been passed by a two-thirds vote of the Executive Committee and presented to the Society in written form at the meeting prior to the meeting at which the vote is taken.

PROC. ENTOMOL. SOC. WASH.
98(3), 1996, pp. 615–616

Instruction for Authors

General Policy.—Articles for publication are ordinarily accepted only from members of the Society and must be in English. A summary in French, German, Spanish, or Russian is acceptable. Such a summary should be placed immediately after the English abstract and may be a translation of that abstract. Manuscripts should not exceed 15 printed pages (about two and one-half double-spaced typewritten pages equal one page). Manuscripts are peer-reviewed before acceptance. Final acceptance is the responsibility of the Editor. Articles are published in the order received, not the date of acceptance. Immediate publication is available with payment of full page charges. Notes, book reviews, and obituaries are published as space is available.

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2. Abstract; key words
3. Text of paper; acknowledgments at end
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Taxonomic papers.—Taxonomic papers must conform to requirements of the International Code of Zoological Nomenclature. In addition, type specimens must be designated for new species described, type depositories must be clearly indicated, and new taxa must be clearly differentiated from existing taxa by means of keys or differential diagnoses. In short, these papers must conform to good taxonomic practices.

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OF WASHINGTON

ORGANIZED MARCH 12, 1884

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MEMBERSHIP.—Members shall be persons who have demonstrated interest in the science of entomology. Annual dues for members are $25.00 (U.S. currency).

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The Society does not exchange its publications for those of other societies.

PLEASE SEE PP. 615–616 OF THE JULY 1996 ISSUE FOR INFORMATION REGARDING PREPARATION OF MANUSCRIPTS.

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THE HOST RANGE OF *ACONOPHORA COMPRESSA* WALKER (HOMOPTERA: MEMBRACIDAE): A POTENTIAL BIOLOGICAL CONTROL AGENT FOR *LANTANA CAMARA* L. (VERBENACEAE)

W. A. Palmer, B. W. Willson, and K. R. Pullen

(WAP) Tropical Weeds Research Centre, Queensland Department of Natural Resources, P.O. Box 187, Charters Towers, Queensland, Australia 4820; (BWW) Alan Fletcher Research Station, Queensland Department of Natural Resources, 27 Magazine Street, Sherwood, Queensland, Australia 4075; (KRP) 112 Irvine Street, Watson, ACT, Australia 2602.

Abstract.–The membracid *Aconophora compressa* Walker is endemic to the Neotropics where it is found on various species of *Lantana.* Host range tests were conducted to ascertain whether it would be safe to introduce and release this insect in Australia for the biological control of *Lantana camara,* a serious weed in many tropical and subtropical countries. These tests, conducted in both Mexico and Australia, indicated that *A. compressa* was narrowly stenophagous. In all tests *A. compressa* oviposited and immatures developed on *L. camara.* In one of three tests oviposition and nymphal development occurred on *Duranta repens* and in two tests oviposition but not nymphal development occurred on *Jacaranda* spp. Oviposition did not occur on 55 other plant species tested. Permission to release this treehopper was obtained, and it was released in Queensland in 1995.

Key Words: Lantana, biological control, treehopper, *Aconophora*

The woody shrub *Lantana camara* L. (family Verbenaceae; subfamily Verbenoideae) is one of the world's ten worst noxious weeds (Muniappan et al. 1992) and infests millions of hectares of grazing and cropping land in 47 countries (Holm et al. 1977). Its highly aggressive nature leads to its taking over rangeland (Perkins and Swezey 1924, Kleinschmidt and Johnson 1977, Cilliers and Neser 1991), particularly gullies and hillsides with rich soils. Some varieties are also poisonous to livestock (Everist 1974).

Lantana camara has long been a target for biological control because it is an introduced plant, it infests rangelands where it may not be economic to treat with herbicides or clear physically, and because herbicide programs have not been particularly effective. Over a period of nearly 100 years there has been a number of investigations (Perkins and Swezey 1924, Winder and Harley 1983) resulting in 32 insect species being released in various countries (Julien 1992); a number easily surpassing that for any other weed species. However, effective control has been achieved only in parts of Hawaii (Perkins and Swezey 1924, Harley 1974). The biological control achieved in Australia is considered only partially effective (Winder and Harley 1983) and more biological control agents are desired (Taylor 1989).

A survey of the insect fauna on *L. camara* and three closely related congeners in North America was recently conducted

Table 1. Known host plants of eight species of *Aconophora* most according to Dietrich and Dietz (1991). Hosts on which immatures have also been found are denoted with an asterisk.

Species	Hosts
A. mexicana Stål	Anacardiaceae, Fabaceae, *Guanabanus* sp.*, *Piper auritum*
A. elongatiformis Dietrich	*Baccharis* sp.*, Fabaceae, Piperaceae*
A. elongata Dietrich	Fabaceae
A. compressa	*Lantana camara,* L. urticifolia**, *L. hispida, Lippia myrocephala*
A. laminata Fairmaire	*Theobroma cacao, Lupinus* sp., *Baccharis conferta, Tetracera* sp.*
A. albipennis Dietrich	*Juniperus* sp., *Solanum tuberosum*
A. robusta Dietrich	*Alchornea* sp.*, *Croton gossipifolius**
A. marginata Walker	*Gladiolus*

(Palmer and Pullen 1995) to find further biological control agents. One species targeted for further study in that investigation was the membracid *Aconophora compressa* Walker, which was found to be damaging plants around Cuernavaca, Mexico. This paper reports the studies into the treehopper's biology and host range that were conducted before it could be released in Australia.

Biology

The tribe Aconophorini (Homoptera: Membracidae) consists of three genera: *Aconophora* Fairmaire, *Calloconophora* Dietrich and *Guayaquila* Goding (Dietrich and Deitz 1991). All of the Aconophorini are gregarious and subsocial, that is females guard their egg-masses and usually remain with nymphal aggregations throughout their development (Dietrich and Deitz 1991). Females guarding eggs sometimes aggressively confront predators with buzzing wings and physical contact. When disturbed, aggregations of adults usually disperse explosively but usually reaggregate, often at the original site. Ant mutualism is associated with the genus *Guayaquila* but has been observed with no species of *Aconophora* (Dietrich and Deitz 1991).

Female *A. compressa* oviposit up to 65 eggs to form a single cluster on stems. These eggs are oviposited over a number of days in a white froth, which hardens when dry so that the egg mass increases in size over the period of deposition. The female remains with this egg mass and its resultant progeny for the rest of her life. The eggs, each approximately 1.2 × 0.4 mm, hatch 14–20 days after oviposition. Nymphal development takes 4–6 weeks and usually involves 5 instars. The nymphs remain in an aggregation close to the empty egg mass and their mother.

Host Range and Phenology

Aconophora compressa occurs from Colombia in South America, through Central America, to Mexico. Three specimens were collected in Arizona, USA in 1930 (Dietrich and Deitz 1991). As this is the only record of an Aconophorini occurring north of Mexico it may be regarded with some doubt. In all probability the northern end of its range is Sinaloa, Mexico, some 400 k south of the of the United States border. *Aconophora compressa* is therefore essentially Neotropical. Within Mexico it is more common in central and southern areas. In the recent survey (Palmer and Pullen 1995) it was found at Veracruz and Oaxaca but was most abundant around Cuernavaca in the state of Morelos.

Aconophora compressa is a multivoltine species found throughout the year. Populations increase throughout the growing season (June–December) and are greatest at the end of that time and in the ensuing three months. Damaging numbers may occur from November to February.

The genus *Aconophora* includes 13 spe-

cies (Dietrich and Deitz 1991). Hosts for 8 of these species are known (Table 1). Most congeners are fairly polyphagous. Older host record data must be treated with caution because the genus was substantially revised (Dietrich and Deitz 1991). The concept of *A. compressa* in particular has been in confusion since Goding (1928) transferred it to the genus *Guayaquila* and synonomized it with *A. caliginosa* Walker and *G. maxima* Goding without examining the type species (Dietrich and Deitz 1991). *Aconophora compressa* has recently (Palmer and Pullen 1995) been collected from *L. camara, L. urticifolia, L. hirsuta* and also from *Lippia myrocephala.* It has also been collected from an unidentified shrub with densely pubescent bark (Dietrich and Deitz 1991).

Host Specificity

Materials and methods.—Three independent experiments were conducted to ascertain the host range of this insect. The first two were conducted at the University of Morelos, Cuernavaca, Mexico prior to the insect being imported into Australia. The third experiment was conducted within quarantine facilities at the Alan Fletcher Research Station, Brisbane.

Experiment 1: The host specificity was assessed using standard, gauze covered cages approximately 1 × 1 × 1 m in dimension. Two replications were conducted; one in January 1991 and the other in February 1991. In each replication one potted plant of eight species was selected and placed in the cage. Adult *A. compressa* from a laboratory colony (20–40) were then introduced into the cage and scattered about so that there was every chance that they would be exposed to all the plants in the cage.

The plants were examined approximately twice a week for at least five weeks. Each plant was examined and the number of adults, egg masses, and nymphs noted. Counts made between the 6th and 37th days were used to estimate the mean population of adults on each plant species. Counts made between the 16th and 37th days were used to estimate the mean number of egg masses on each plant species. Counts made between the 30th and 37th days were used to estimate the mean population of nymphs on each plant species.

Experiment 2: Two plants each of 12 species were selected in March 1991 for a large cage experiment. The selection included 6 species of Verbenaceae, with the remainder being from closely related families. All the plants were examined prior to their selection to ensure that they were in good condition and were free of *Aconophora.* They were then watered before being placed inside a 2 × 3 × 7 m walk-in cage situated on the grounds of the University of Morelos.

The plants were placed inside the cage in two rows; each row containing one plant of each of the 12 species. Within these rows the plants were randomly assigned a position which were equidistant so that no plant was shadowed by its neighbours.

Adult *Aconophora compressa* were collected from one large bush of *L. urticifolia* growing on the university grounds. The insects were collected either by hand or aspirator and placed in plastic vials; fifteen to each vial. One vial was placed at the base of each plant in the experiment so that a total of 360 insects were placed in the cage. The insects then made their own way out of the vial and onto the plant.

The test was assessed twice a week for approximately seven weeks, a time sufficient for the insect to develop through a generation on the test plants. Each plant was examined and the number of colonies, adults, egg masses, and presence of nymphs noted. Six counts taken between the 23rd and 40th day after the experiment commenced, when all stages of the insect were present on the plants, were used to calculate the mean populations of adults, egg masses and nymphs reported here.

Experiment 3: Adult choice tests were carried out using gauze covered cages approximately 90 × 90 × 90 cm. Three rep-

Table 2. A summary of the abundance of adults, egg masses and nymphs found on experimental plants in three experiments conducted to determine the host range of *A. compressa.*

Plant Species	Expt. No.	Mean No. of Adults	Mean No. of Egg Masses	Mean No. of Nymphs
Verbenaceae				
Verbenoideae				
Lantana camara L.	1	7.8	3.3	33.7
L. camara	2	3.9	2.2	24.9
L. camara	3	19.4	8.4	
Lantana montevidensis (K. Spreng.) Briq.	1	0.3	0.0	0.0
L. montevidensis	2	0.0	0.0	0.0
L. montevidensis	3	0.03	0.0	0.0
Verbena carolina L.	2	0.0	0.0	0.0
V. bonariensis L.	3	0.0	0.0	
Duranta repens L.	1	0.4	0.0	0.0
D. repens	2	10.6	2.4	4.5
D. repens var. *lorentzii*	3	0.0	0.0	
Phyla nodiflora (L.) Greene	3	0.03	0.0	
Stachytarpheta urticifolia (Salsb.) Sims	3	0.14	0.0	
Viticoidae				
Callicarpa pedunculata R. Br.	3	0.0	0.0	
Clerodendrum sp.	2	0.0	0.0	0.0
C. cunninghamii Benth.	3	0.0	0.0	
C. tomentosum (Venten.)	3	0.0	0.0	
Petraea volubilis L.	2	0.0	0.0	0.0
Faradaya splendida F. Muell.	3	0.0	0.0	
Gmelina leichhardtii (F. Muell.) Benth.	3	0.0	0.0	
Premna lignum-vitae (Cunn. ex Shauer) Pieper	3	0.0	0.0	
Vitex trifolia L.	3	0.0	0.0	
Caryopteridoideae				
Glossocarya hemiderma (F. Muell. ex Benth.)	3	0.0	0.0	
Annonaceae				
Annona × *squamosa* L.	3	0.0	0.0	
Asteraceae				
Baccharis halimifolia L.	3	0.33	0.0	
Avicenniaceae				
Avicennia marina (Forssk.) var *australasica*	3	0.0	0.0	
Bignoniaceae				
Jacaranda sp.	1	0.3	0.0	0.0
Jacaranda sp.	2	1.1	0.3	0.0
Jacaranda acutifolia Humb. & Bonpl.	3	3.1	0.3	
Pandorea pandorana (Andr.) Steenis	3	0.0	0.0	
Boraginaceae				
Cordia dichromata G. Forster	3	0.0	0.0	
Ehretia acuminata R. Br.	3	0.03	0.0	
Chloanthaceae				
Chloanthes parviflora Walp.	3	0.0		
Spartothamnela juncea (Cunn. ex Walp.) Briq.	3	0.0	0.0	
Convolvulaceae				
Evolvulus alsinoides (L.) L.	3	0.0	0.0	
Ipomoea batatas (L.) Lam.	3	0.0	0.0	

Table 2. Continued.

Plant Species	Expt. No.	Mean No. of Adults	Mean No. of Egg Masses	Mean No. of Nymphs
I. plebeia R. Br.	3	0.03	0.0	
Polymeria calycina R. Br.	3	0.0	0.0	
Dilleniaceae				
Hibbertia scandens (Willd.) Dryand.	3	0.0	0.0	
Euphorbiaceae				
Croton insularis Baillon	3	0.0	0.0	
Ericaceae				
Azalea sp.	2	0.0	0.0	0.0
Lamiaceae				
Ajuga australis R. Br.	3	0.0	0.0	
A. cf. *reptans* L.	1	0.0	0.0	0.0
Ocimum basilicum L.	1	0.0	0.0	0.0
Lavendula dentata L.	3	0.0	0.0	
Plectranthus argentatus S. T. Blake	3	0.0	0.0	
Prosthantera ovalifolia R. Br.	3	0.0	0.0	
Mentha sp.	1	0.0	0.0	0.0
M. spicata L.	3	0.0	0.0	
Salvia splendens F. Sellow ex Roem. & Scult.	2	0.0	0.0	0.0
S. coccinea Juss. ex J. Murr.	3	0.03	0.0	
Scutellaria formosana N. E. Br.	3	0.0	0.0	
Teucrium argutum R. Br.	3	0.0	0.0	
Westringia fruticosa (Willd.) Druce	3	0.23	0.0	
Mimosaceae				
Acacia podalyriifolia G. Don	3	0.18	0.0	
Acacia concurrens Pedley	3	0.0	0.0	
Malvaceae				
Hibiscus rosa-sinensis L.	2	0.0	0.0	0.0
Myoporaceae	2	0.0	0.0	0.0
Myoporum parvifolium R. Br.	3	0.04	0.0	
Myrtaceae				
Eucalyptus crebra F. Muell.	3	0.0	0.0	
Eucalyptus curtisii Blakely & C. White	3	0.0	0.0	
Eucalyptus sp.	2	0.0	0.0	0.0
Pedaliaceae				
Sesamum indicum L.	3	0.0	0.0	
Piperaceae				
Piper novae-hollandiae Miq.	3	0.0	0.0	
Scrophulariaceae				
Duboisia myoporoides R. Br.	3	0.0	0.0	
Mazus pumilio R. Br.	3	0.0	0.0	
Solanaceae				
Cestrum nocturnum L.	1	0.2	0.0	0.0
Lycopersicon lycopersicum L.	3	0.0	0.0	
Solanum nemophilum F. Muell.	3	0.0	0.0	
S. pseudocapsicum L.	2	0.0	0.0	0.0
S. tuberosum L.	3	0.0	0.0	

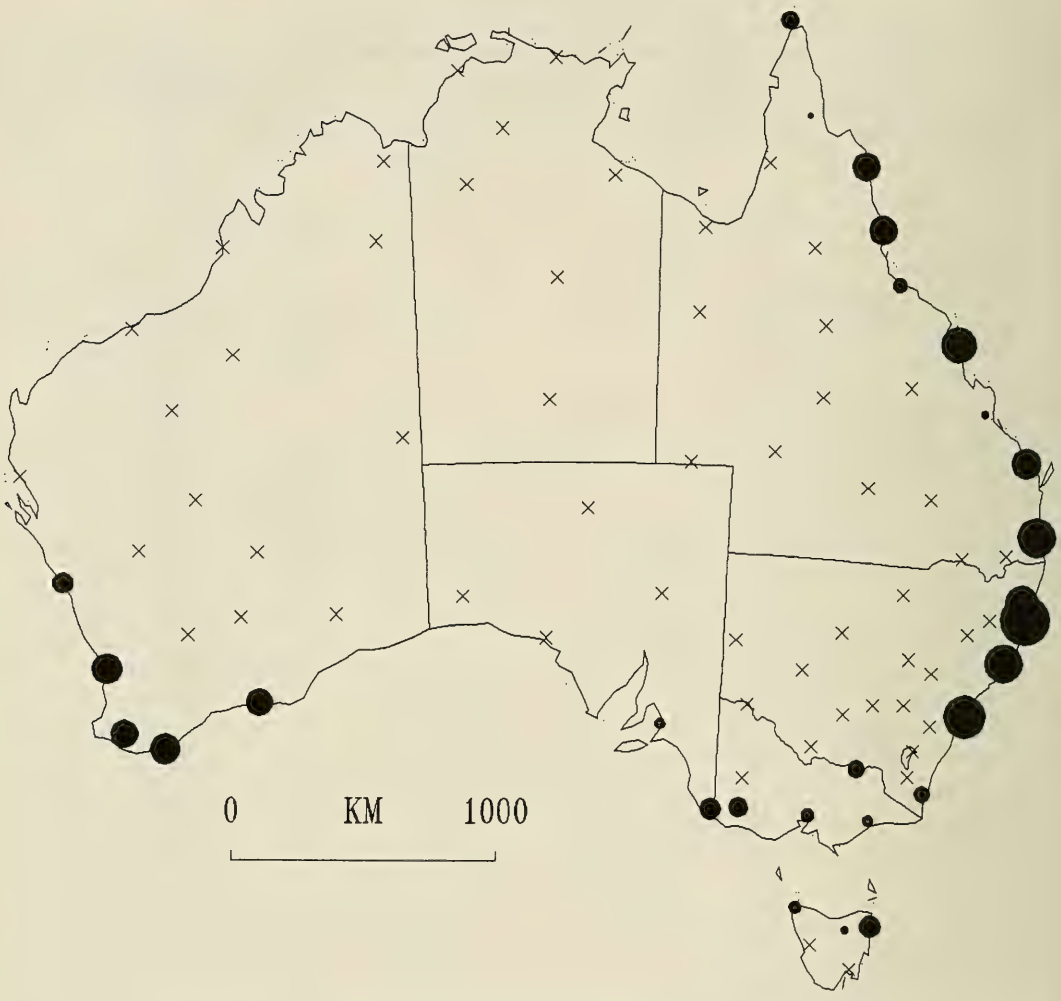

Fig. 1. Predicted distribution of *A. compressa* in Australia based on the climate matching model CLIMEX.

lications were conducted concurrently. In each replication, 9 plant species, always including *L. camara,* were arranged in a cage. Thirty adult *A. compressa* were then scattered into the cage. Counts of the adults on each plant were made between the 6th and 21st day after this introduction. Egg masses were counted on the 21st day.

Results.—The results of all three experiments are given in Table 2. *Lantana camara* was the only plant species on which *A. compressa* consistently oviposited. Oviposition also occurred on both plants of *Duranta repens* L. in one of three experiments and on *Jacaranda* spp. in all three experiments. The egg masses on *D. repens* produced nymphs that then developed normally on that host. Nymphs were never found associated with the egg masses on *Jacaranda* indicating that this plant is an unsuitable host.

Altogether this insect was tested against 62 plant species of which 17 were of the Verbenaceae and 13 and 5 species were of the closely related Lamiaceae and Solanaceae, respectively. The insect was in fact thoroughly tested along the centrifugal design advocated by Wapshere (1975). All evidence suggests that the host range of this insect is limited to *Lantana* and close-

ly related genera such as *Duranta* and *Lippia.*

Release in Australia

Permission to release this insect in Australia was sought even though it could breed on Mexican varieties of *D. repens* (subfamily Verbenoidae). From an Australian perspective *D. repens* is an introduced ornamental suspected of being poisonous to children and stock (Everist 1974). The Verbenoidae is represented in Australia by one native species, *Verbena macrostachya,* which is found only in inland Queensland far from the habitat of *L. camara.*

Approval to release *A. compressa* was obtained in early 1995 and a mass rearing program outside the quarantine facilities was initiated. The climate matching model CLIMEX (Sutherst and Maywald 1985, Skarratt et al. 1995) was utilized in the selection of release sites. The model indicated (Fig. 1) that *A. compressa* should adapt to conditions along the eastern seaboard of Australia where *L. camara* is a problem. Conditions in southern Queensland and northern New South Wales should be particularly favorable.

First releases were made near Brisbane in May 1995 and at Charters Towers in October 1995.

Discussion

We anticipate that *A. compressa* will be a useful biocontrol agent if it establishes successfully. In Mexico it is quite damaging especially when a plant is attacked by multiple colonies. One reason for optimism is that its action will be largely independent of leaf status. *Lantana* has the ability to drop its leaves when stressed and uses this mechanism to survive periods of drought, cold, insect attack and possibly herbicide application. This reduces the effect of insects that attack foliage.

With the notable exception of the Coccoidea, the Homoptera have not been greatly used in biological control of weeds (Julien 1992). The psyllid *Heteropsylla* sp., released against *Mimosa invisa* L., and the aphid *Aphis chloris* Koch, released against *Hypericum perforatum* L., are other examples of Sternorrhyncha listed by Julien (1992). The only instance, to our knowledge, of the Auchenorrhyncha being so used is that of *Stobaera concinna* (Stål) released for *Ambrosia artemisiifolia* (L.) and *Parthenium hysterophorus* L. (Julian 1992). The reasons why the Homoptera other than Coccoidea have been so eschewed include the perception that most are polyphagous, that many are vectors of plant diseases, that they may be a greater than normal risk in quarantine facilities, that they are difficult to ship, and that their effects on the plant are slight or difficult to define.

Apart from *A. compressa* being the first use of a membracid for biological control, its progress will be of interest because it feeds on stems externally. Endophagous species such as stem borers and gall formers are more commonly used but there are few examples of ectophagous stem utilizers.

Acknowledgments

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BIOLOGY AND LARVAL TAXONOMY OF *EUCELATORIA BRYANI* SABROSKY AND *E. RUBENTIS* (COQUILLETT) (DIPTERA: TACHINIDAE)

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Abstract.—The tachinid flies *Eucelatoria bryani* Sabrosky and *E. rubentis* (Coquillett) are similar in their reproductive behaviors and will mate with one another under laboratory conditions; however, sperm is not transferred. Both species parasitize noctuid caterpillars, with the host range of *E. rubentis* being about four times broader than that of *E. bryani,* which is essentially restricted to *Heliothis virescens, H. subflexa* and *Helicoverpa zea.* Larvae of the two species can be separated from one another as second and third instars primarily by the shape of the dorsal cornu of the tentoropharyngeal sclerite. Both tachinids offer great promise as biological control agents of noctuid pests.

Key Words: Diptera, Tachinidae, *Eucelatoria, Heliothis, Helicoverpa,* host-parasite relations

The Tachinidae comprise the largest family of parasitic Diptera and have great potential economic importance as biological control agents. However, of the approximately 8000 described species of Tachinidae in the world, most are only known on the basis of adult morphology. Often, the characters used for distinguishing species or genera are subtle and of uncertain biological importance (Wood 1987). This lack of information constrains the use of tachinids as biological control agents, a problem that could be alleviated by information on other life stages and biological traits.

Eucelatoria bryani Sabrosky and *E. rubentis* (Coquillett) are two potentially important biological control agents (Knipling 1992). These two tachinids are sympatric across the south-central USA and northeastern Mexico. The geographic range of *E. bryani* extends from western Arkansas and eastern Oklahoma, south and west to Arizona and Mexico (Jackson et al. 1969, Young and Price 1975, Sabrosky 1981, Steward et al. 1990). *Eucelatoria rubentis* occurs across the southeastern USA from Delaware south through Florida, and west to Arkansas, Texas and Tamaulipas, Mexico (Sabrosky 1981). *Eucelatoria bryani* and *E. rubentis* can be differentiated on the basis of adult characters (Sabrosky 1981). Here we provide further diagnostic information by presenting the larval taxonomy and a synopsis of biological characters for both species.

MATERIALS AND METHODS

Our colony of *E. bryani* was derived from material originally collected from corn (*Zea mays* L.) in Arizona and later cultured in USDA laboratories in College Station and Weslaco, Texas. The colony of *Eucelatoria rubentis* was derived from material collected and maintained in culture at the USDA laboratory in Tifton, Georgia. Both colonies were reared at Clemson University

in *Helicoverpa zea* (Boddie) and *Heliothis virescens* (F.), according to methods described by Nettles et al. (1980) and Reitz and Adler (1991).

Larvae for taxonomic study were dissected from singly-parasitized hosts (*H. zea*), boiled in lactic acid, slide-mounted (cephalopharyngeal skeletons in lateral view) in Euparal®, and examined with an Olympus BH-2 compound microscope fitted with an ocular micrometer. Voucher material is deposited in the Clemson University Arthropod Collection.

Methods for interspecific mating trials follow those of Reitz and Adler (1991). Briefly, 2-day old, virgin males were placed in a plexiglass arena (15 × 10 × 10 cm). Five minutes later, one newly eclosed heterospecific female was introduced into the arena and all interactions were recorded. Additional heterospecific groups were held together for up to 5 days, after which females were dissected in physiological saline and examined for the presence of sperm in the spermathecae and embryonated eggs in the common oviduct.

To determine the suitability of various species of Noctuidae as hosts, feeding-stage fifth instars (≥20) of each noctuid were presented to individual 2-wk old females, or larvae were placed in cages containing 50–100 adult flies for 30–120 min. Larvae were then returned individually to 31-ml plastic cups containing a suitable meridic diet and inspected daily for the presence of parasitoids.

Results and Discussion

Larval taxonomy.—The three larval instars of each species can be distinguished on the basis of size and development of the cephalopharyngeal skeletons (Fig. 1). The posterior spiracles are well-developed, with three slits each, only in the third instar (Fig. 1). Instar 1 has three blunt hooks surrounding the posterior spiracles, whereas instar 2 has two pairs of hook plates around the posterior spiracles; hook plates are absent in third instars. All instars have 12 bands of microspines around the body, although the terminal (12th) band, surrounding the posterior spiracles, is weakly developed.

Second and third instars of the two species can be distinguished most readily by the development of the dorsal cornu of the tentoropharyngeal sclerite, which is significantly greater in height and more massive anteriorly in *E. rubentis* than *E. bryani* (Table 1, Fig. 1). Additionally, third instars of *E. bryani* have significantly more papillate openings (range: 3–5 each) at the apex of the anterior spiracles than do those of *E. rubentis* (2 or 3) (Table 1). The posterior spiracles of the third instar (Fig. 1D) are similar, although the sclerotization between spiracular slits tends to be darker in *E. rubentis*. First instars cannot be separated reliably.

Interspecific matings.—Under laboratory conditions, these two species are reproductively isolated. For both species, the emergence pattern is protandrous, females are monogamous, and males are polygamous. The courtship behaviors of *E. rubentis* are similar to those described for *E. bryani* (Reitz and Adler 1991). Males of both species mounted heterospecific females and initiated courtship. These interspecific courtships continued in a manner similar to that described for *E. bryani* by Reitz and Adler (1991), with males of both species attempting intromission with heterospecific females. However, based on examination of spermathecae after mating attempts, sperm transfer did not occur and these females did not produce embryonated eggs (n = 8 for *E. bryani* male × *E. rubentis* female; n = 6 for *E. rubentis* male × *E. bryani* female).

Host specificity.—We successfully reared *E. bryani* from *H. zea, H. virescens,* and *Heliothis subflexa* (Guenée). Attempts to rear *E. bryani* from other Noctuidae including *Anticarsia gemmatalis* Hübner, *Pseudoplusia includens* (Walker), *Spodoptera ornithogalli* (Guenée), and *Trichoplusia ni* (Hübner) were unsuccessful. *Eucelatoria bryani* has been reared from field-collected *A. gemmatalis, Spodoptera frugiperda*

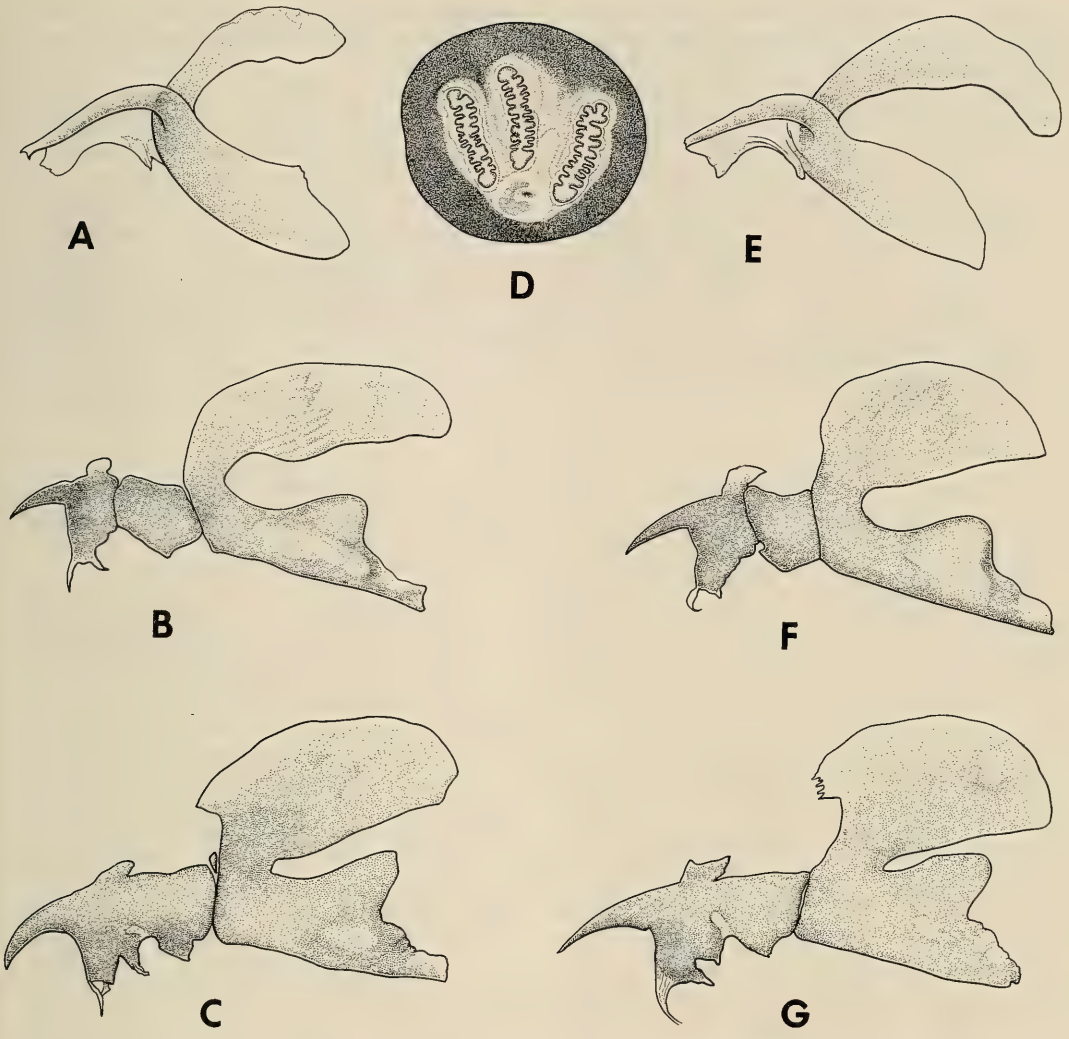

Fig. 1. Larval features of *Eucelatoria.* A–C, *E. bryani,* cephalopharyngeal skeletons (lateral). A, First instar. B, Second instar. C, Third instar. D, *E. bryani,* posterior spiracle of third instar. E–G, *E. rubentis,* cephalopharyngeal skeletons (lateral). E, First instar. F, Second instar. G, Third instar.

(Smith) and *T. ni,* but these host records are rare compared with those from *H. zea* and *H. virescens* (Butler 1958, Sabrosky 1981).

In contrast, we successfully reared *E. rubentis* from *H. zea, H. virescens,* and *H. subflexa, A. gemmatalis,* and *P. includens.* Based on field collections, host species for *E. rubentis* include these species as well as 12 other species of Noctuidae and Pyralidae (Arnaud 1978, Sabrosky 1981). The basis for this interspecific difference in host range appears to be the failure of *E. bryani* females to oviposit in hosts. Nettles (1980) found *E. bryani* females were attracted to *H. virescens* but not to *Spodoptera eridania* (Cramer) or *Estigmene acrea* (Drury).

Females of both species deposit progeny in proportion to host size (Reitz 1996a), but progeny of *E. bryani* tend to be smaller and develop more rapidly than those of *E. rubentis.* Because of its more rapid development, *E. bryani* is a superior intrinsic competitor compared with *E. rubentis* when parasitizing *H. zea* (Reitz 1996b).

Table 1. Selected larval features, mean ± SE, *n*, of *Eucelatoria bryani* and *E. rubentis*. Means with different letters are significantly different for each character within each instar (t-test; $P < 0.005$); other values are not significantly different ($P > 0.05$); n.o., not observed.

Species	Instar	Cephalopharyngeal Skeleton, Length[1]	Dorsal Cornu, Height[2]	Number of Anterior Spiracular Openings
E. bryani	1	0.16 ± 0.004 (10)a	0.02 ± 0.001 (10)a	n.o.
E. rubentis	1	0.18 ± 0.011 (8)a	0.02 ± 0.002 (7)a	n.o.
E. bryani	2	0.33 ± 0.008 (10)a	0.07 ± 0.002 (10)a	n.o.
E. rubentis	2	0.34 ± 0.007 (6)a	0.09 ± 0.002 (6)b	n.o.
E. bryani	3	0.67 ± 0.013 (11)a	0.16 ± 0.003 (11)a	3.7 ± 0.17 (11)a
E. rubentis	3	0.76 ± 0.020 (10)b	0.19 ± 0.006 (10)b	2.6 ± 0.17 (10)b

[1] Tip of mandible to posterior of dorsal cornu in mm.
[2] Greatest height in mm.

Potential for biological control.—Given that both species are facultatively gregarious (Reitz 1996a) and have relatively high fecundities (Gross and Rogers 1995, Reitz and Adler 1995), both species could be important biological control agents. Knipling (1992) considered *E. bryani* to be one of the most important parasitoids of *H. zea* and *H. virescens* and proposed a plan for using *E. bryani* to suppress these host populations. The possibility exists for using *E. rubentis* in a similar program against other pest noctuids. While host specificity is a desirable attribute of biological control agents (e.g. Greathead 1986), polyphagy is not necessarily a detrimental attribute, if a polyphagous parasitoid attacks several sympatric pest species (Ehler and van den Bosch 1974). The potential for using augmentative releases of *E. bryani* and *E. rubentis* would be further enhanced with continued refinement of *in vitro* rearing methods (Bratti and Nettles 1992). No one biological control agent is likely to manage a pest population completely, but if used properly, *E. bryani* offers an excellent opportunity to help manage *H. zea,* and *E. rubentis* offers a similar opportunity to help manage several other noctuid pests.

Acknowledgments

We thank J. P. Norton for rendering the illustrations, and C. N. Watson for technical assistance. This is technical contribution No. 4177 of the South Carolina Agricultural Experiment Station, Clemson University.

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A NEW SPECIES OF *MEZIRA* AMYOT AND SERVILLE (HETEROPTERA: ARADIDAE) FROM FLORIDA, WITH A KEY TO THE SMALL *MEZIRA* SPECIES OF AMERICA NORTH OF MEXICO

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Abstract.—***Mezira froeschneri*** n. sp. is described from Florida. A key to the small *Mezira* species of America north of Mexico, including *M. froeschneri,* is provided.

Key Words: Heteroptera, Aradidae, *Mezira,* diagnostic key, *Mezira froeschneri,* North America

The aradid genus *Mezira* contains about 160 species worldwide (Kormilev and Froeschner 1987), nine of which occur in America north of Mexico (Froeschner 1988). Blatchley (1926) constructed a key to four species from eastern North America and Usinger (1936) for seven species from America north of Mexico, including those treated by Blatchley. Both authors used body length (5.5 mm or less, 6.5–7.0 mm or more) as a distinguishing character in the first couplet of their keys; those species 5.5 mm or less were *M. granulata* (Say) and *M. novella* Blatchley.

Two species have been added to the fauna of America north of Mexico since Usinger's (1936) key. Kormilev (1982a) described *M. smithi,* which is 6.6 mm long, and (1982b) *M. sayi,* which is 5.3 mm long in males, 6.45 mm in females. He (1982b) also provided a key to the small (5.3–6.45 mm) species of *Mezira* (i.e., *M. granulata, M. novella,* and *M. sayi*). Here we describe *M. froeschneri,* a small species from Florida, and include a key to these four species.

KEY TO THE SMALL *MEZIRA* SPECIES OF AMERICA NORTH OF MEXICO

1. Genae forming notch anterior to clypeus (Fig. 1); pronotum subrectangular (Fig. 3); pygophore in lateral view angulate apically, slightly rounded posteroventrally (Fig. 5), in dorsal view with median longitudinal ridge reaching apex (Figs. 7, 11); female in dorsal view with paratergite 9 usually exceeding tergite 9 by at least half width of paratergite 9 (Fig. 12), genitalia in ventral view with pair of median, shallow longitudinal grooves that are parallel throughout length (Fig. 15) . . . . . *M. froeschneri,* n. sp.

– Genae with or without notch anterior to clypeus (Fig. 2); pronotum subtrapezoidal (Fig. 4); pygophore in lateral view broadly rounded posteriorly (Fig. 6), in dorsal view with median longitudinal ridge not reaching apex (Figs. 8–10); female in dorsal view with paratergite 9 usually exceeding tergite 9 by less than half width of paratergite 9 (Fig. 13) or paratergite 9 not exceeding tergite 9 (Fig. 14), genitalia in ventral view with pair of median, shallow longitudinal grooves that diverge anteriorly (Fig. 16) 2

2. Scutellum with lateral margins of median longitudinal ridge carinate; pygophore with median longitudinal ridge greater than 90% of length of tuberculate area, tuberculate area with anterolateral region expanded into broad lobe (Fig. 8) . . . . . *M. novella*

– Scutellum with lateral margins of median longitudinal ridge rounded, irregular, often obscured by tubercles; pygophore with median longitudinal ridge less than 90% of length of tuberculate area, tuberculate area with antero-

lateral region not expanded into broad lobe (Figs. 9, 10) 3

3. Body with long, thick, erect setae; pygophore with median longitudinal ridge averaging 84% length of tuberculate area (Fig. 9); paratergite 8 with maximum width averaging 1.2 times length of tuberculate area beyond median longitudinal ridge (Fig. 9); parameres as in Figs. 17–20 . . . . . *M. granulata*

– Body with short, thin, appressed setae, each seta curving around associated tubercle; pygophore with median longitudinal ridge averaging 77% of length of tuberculate area (Fig. 10); paratergite 8 with maximum width averaging 0.8 times length of tuberculate area beyond median longitudinal ridge (Fig. 10); parameres as in Figs. 21–24 . . . . . *M. sayi*

Mezira froeschneri Davidová-Vilímová, Taylor, and McPherson, new species

(Figs. 1, 3, 5, 7, 11–12, 15, 25–29; Table 1)

Ground color brown to brownish black, often with scattered darker areas, particularly dorsally. Dorsal surface with sclerotized areas tuberculate; occasional larger, black tubercles also present, most frequently limited to lateral margins, but may be scattered elsewhere on sclerotized areas. Appressed setae present, most numerous dorsally, each seta curving around associated tubercle.

Head (Fig. 1) with clypeus elevated medially. Genae exceeding clypeus, producing V-shaped notch; each gena broadly lobe-shaped. Antenniferous tubercle well developed, acute apically, directed anterolaterally, extending half the length of antennal segment 1. Postocular tubercle well developed, posterior margin carinate. Vertex elevated. Antennae with segment 1 broadest, distinctly clavate; segment 2 clavate; segment 3 elongate, clavate; segment 4 clavate, subacute apically with conspicuous setae. Ventrally, atrium present anterior to and continuous with rostral groove, atrium narrowed medioventrally. Rostral groove distinct, wide, with lateral margins subparallel in middle half, converging anteriorly and posteriorly. Rostrum reaching posterior margin of rostral groove.

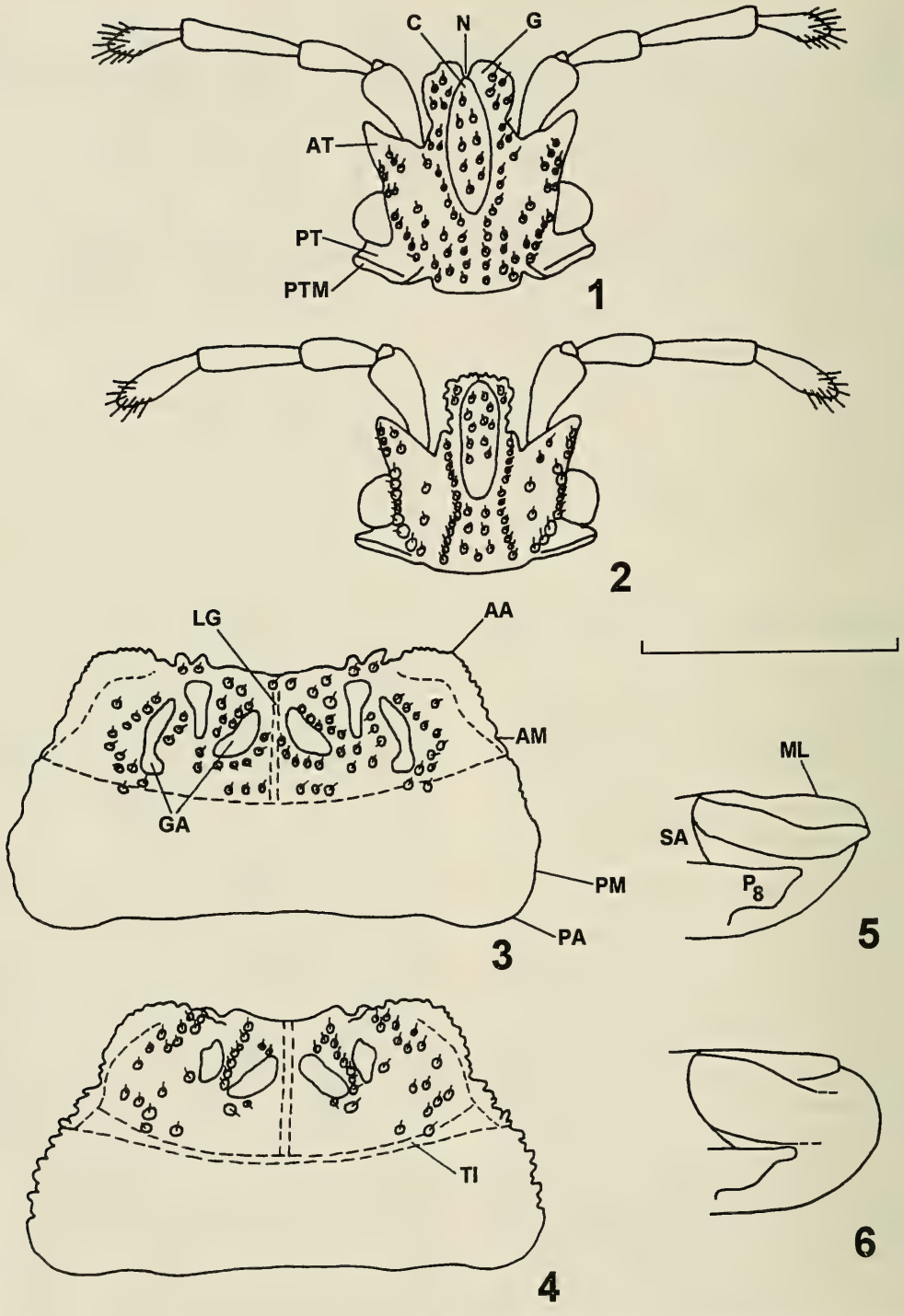
Pronotum (Fig. 3) subrectangular, wider posteriorly than anteriorly. Weak, median longitudinal groove present in anterior half. Weak, irregular, transverse impression present in middle third, laterally curving anteriorly. Anterolateral margins almost straight, with no distinct sinus. Three to four pairs of glabrous areas in anterior half.

Scutellum (Fig. 29) subtriangular, width at base about half that of pronotum at posterior margin, lateral margin straight to shallowly concave in middle half; all margins conspicuously elevated and carinate except at apex. Subbasal transverse, and median longitudinal, ridges present.

Hemelytron (Fig. 29) (including membrane) with lateral margin sinuate. Clavus, corium, and membrane distinct. Clavus and corium with much of surface rugose. Corium with lateral margin broadly angulate in proximal half; distal margin along membrane convex laterally, remainder weakly sinuate. Membrane reaching or nearly reaching posterior margin of tergum 6.

Thoracic pleura with scattered tubercles. Coxae widely separated. Metathoracic scent glands with both opening and evaporative area inconspicuous and immediately posterior to mesocoxae.

Abdominal terga 2–6 covered medially by hemelytra, outer margin of posterior two thirds of corium and entire membrane bordered by carinate elevation of abdomen. Tergum 7 strongly elevated medially in males; slightly elevated medially, enclosing weak median depression, in females; posterior margin concave in both sexes, concavity deeper in males. Connexivum 2 subtriangular; connexiva 2–5 subquadrate; connexivum 6 subtrapezoidal; connexivum 7 subtriangular; lateral margins of 2–5 straight, of 6–7 slightly convex. Terga 3–6 with two rounded glabrous areas on either side of wing, glabrous areas on tergum 7 indistinct; connexiva 2–7 each with two rounded glabrous areas (connexivum 7 with only one glabrous area in females). Venter moderately convex. Spiracles 2–8 ventral, conspicuous; 2–6 equidistant from lateral



Figs. 1–6. 1, 3, 5, *Mezira froeschneri.* 1, Head. 3, Pronotum (representative tubercles shown only on anterior lobe). 5, Pygophore, lateral view. 2, *M. granulata,* head. 4, 6, *M. sayi.* 4, Pronotum (representative tubercles shown only on anterior lobe). 6, Pygophore, lateral view. Scale: 1.0 mm for all figs. Abbreviations: AA = anterolateral angle of pronotum, AM = anterolateral margin of pronotum, AT = antenniferous tubercle, C = clypeus, G = gena, GA = glabrous area, LG = longitudinal groove on pronotum, ML = median longitudinal

margin, 7 closer, 8 almost lateral in position and markedly smaller.

Male external genitalia: Pygophore (Figs. 5, 7, 11) smooth anteriorly, tuberculate posteriorly, usually only tuberculate area visible. Tuberculate area higher than smooth area at junction; anterior border with median notch, bisinuate each side of midline with submedian notch. Elevated, median, longitudinal ridge reaching apex of pygophore, narrower anteriorly, broader posteriorly, divided by longitudinal line that apparently represents junction of medial margins of parandria. Pair of broad submedian grooves, each originating mesad of submedian notch, paralleling median ridge, diverging posteriorly. Pygophore, in lateral view, angulate apically, slightly rounded posteroventrally (Fig. 5); smooth area, dorsally, with large central external opening (Fig. 11) surrounding anal cone (segments 10 + 11) and parameres (Fig. 7); posteriorly, median expansion present with submedian excavation each side (Fig. 11), expansion comprised of two subtriangular plates; small setae present dorsolaterally on outer surface and on rim of external opening. Each paramere inserted in lateral excavation; parameres cover phallus in resting position.

Paramere (Figs. 25–28) with base narrower than peduncle, widening to hypophysis. Base with conspicuous, sharp, longitudinal flange. Peduncle with longitudinal, rugose, wide carina on medial surface, longitudinal fold on posterior surface. Hypophysis trilobate in dorsal view (Fig. 7); lateral lobe low in anterior (Fig. 28) and posterior (Fig. 25) views, rounded in dorsal view (Fig. 7); median lobe subtruncate in posterior view, lower angle acute; anterior lobe most apical, rounded; peduncle with setae on anteromedial surface just below anterior lobe (Figs. 26–28).

Female terminalia: Tergite 8 (Fig. 12) weakly convex medially, anterior margin slightly convex, posterior margin slightly concave; paratergites 8 reaching about half length of tergite 9. Tergite 9 triangular, lateral margins elevated; paratergites 9, in dorsal view, elongate, narrow, reaching or exceeding apex of tergite 9; paratergites 9, in ventral view (Fig. 15), subtriangular, medially with longitudinal, shallow groove each side of midline, grooves becoming obsolete anteriorly.

Measurements: See Table 1.

Type material.—Holotype ♂: "FLORIDA: Leon Co., Tallahasse, 20-III-1976, coll. C. W. O'Brien & G. B. Marshall (Berlese mixed hardwood litter), *Mezira* sp.?, det. N. Korimelev, 85." Allotype ♀: Same data as holotype. Paratypes: All specimens were collected from leaf litter with a Berlese funnel except for those collected on 12 June 1974 and 28 June 1976, where no collection method and microhabitat were indicated. Collections from mixed hardwood litter are indicated as MHL, those from hardwood litter as HL. Specimens collected by C. W. O'Brien, G. B. Marshall, and L. D. Justice are indicated by CWO, GBM, and LDJ, respectively. FL: Franklin Co.: 2 ♀, 3 mi. NW Alligator Pt., 12 Dec. 1975, coll. GBM (Sand pine & oak litter); Gadsden Co.: 1 ♂, 1 ♀, 1 mi. E Havana, 6 Jan. 1977, coll. CWO and GBM (Pine-hardwood litter); Hamilton Co.: 2 ♀, 8 mi. S of Jasper, Hwy. 129, 24 March 1977, coll. CWO "et al." (MHL); Lafayette Co.: 2 ♀, 10 mi. NW Mayp, Hwy. 27, 24 March 1977, coll. CWO "et al." (MHL); Leon Co.: Tallahassee: 1 ♂, 4 Feb. 1976, coll. GBM (HL); 1 ♂, 6 ♀, 16 Feb. 1976, coll. CWO (HL); 3 ♀, 4 March 1976, coll. GBM (HL); 1 ♀, 5 March 1976, coll. LDJ (HL); 3 ♂, 1 ♀, 20 March 1976, coll. CWO and

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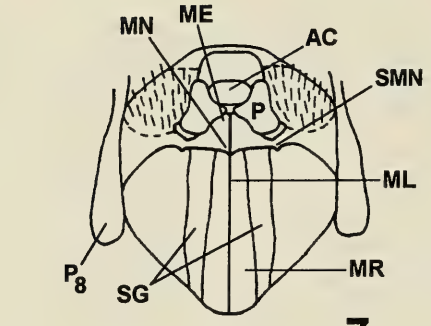
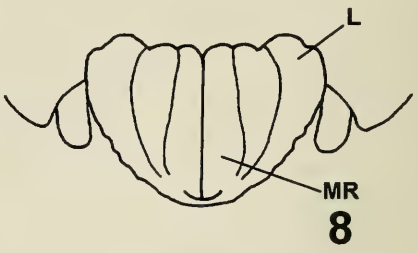
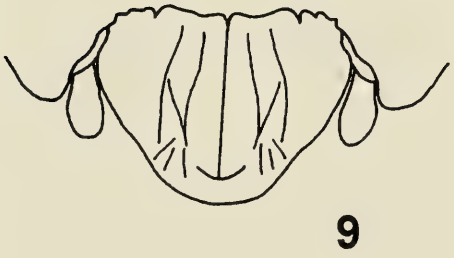
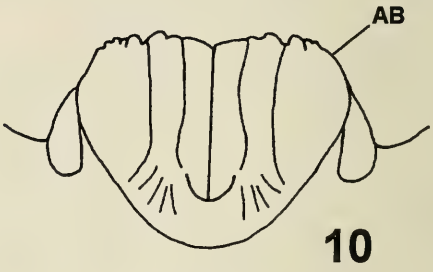
←

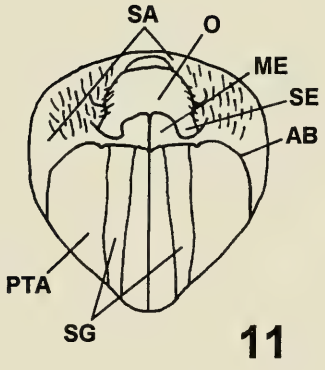
line on pygophore, N = notch, P_8 = paratergite 8, PA = posterolateral angle of pronotum, PM = posterolateral margin of pronotum, PT = postocular tubercle, PTM = posterior margin of postocular tubercle, SA = anterior smooth area of pygophore, TI = transverse impression on pronotum.

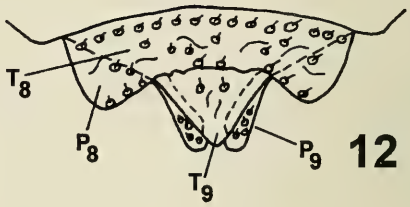


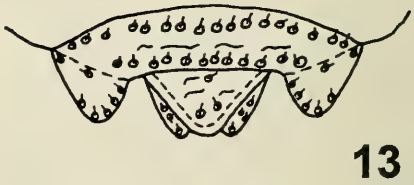


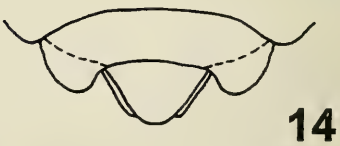




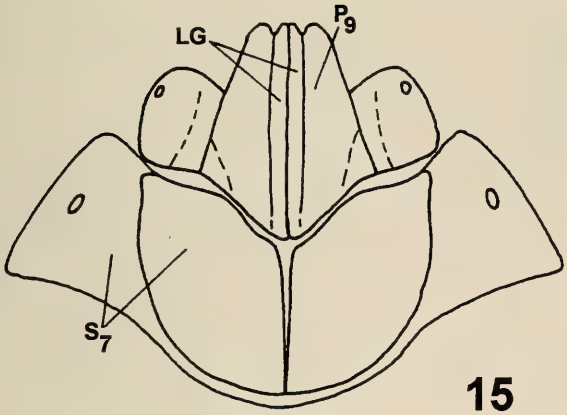


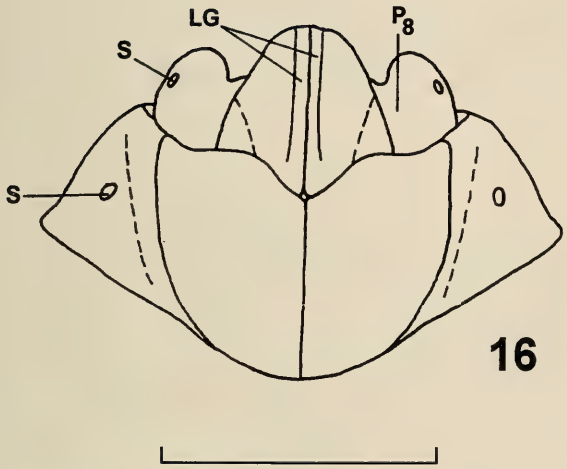


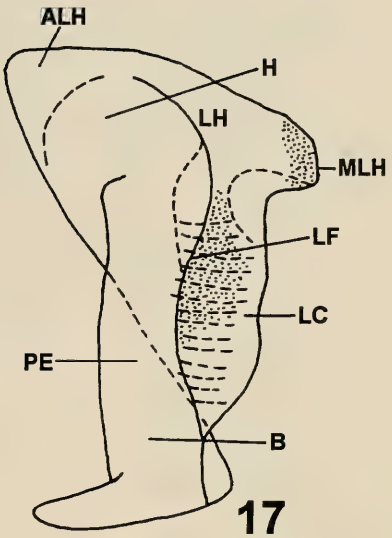


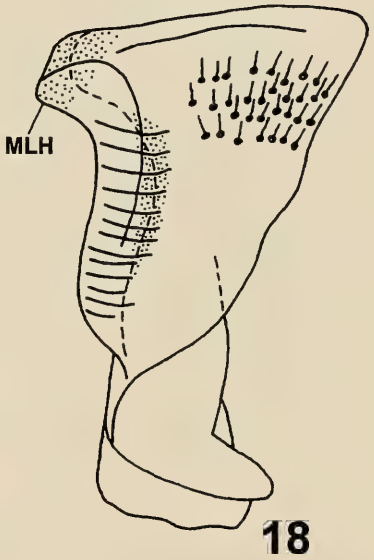


Figs. 7–14. 7, 11, 12, *Mezira froeschneri.* 7, 11, Pygophore, dorsal view. 12, Female terminalia, dorsal view. 8, 14, *M. novella.* 8, Pygophore, dorsal view. 14, Female terminalia, dorsal view. 9, 13, *M. granulata.* 9, Pygophore, dorsal view. 13, Female terminalia, dorsal view. 10, *M. sayi,* pygophore, dorsal view. Scale: 1.0 mm for all figs. Abbreviations: AB = anterior border of tuberculate area of pygophore, AC = anal cone, L = lobe of tuberculate area of pygophore, ME = median expansion of smooth area of pygophore, ML = median longitudinal line on pygophore, MN = median notch of pygophore, MR = median longitudinal ridge on pygophore, O = external opening of pygophore, P_8 = paratergite 8, P_9 = paratergite 9, P = paramere, PTA = posterior tuberculate area of pygophore, SA = anterior smooth area of pygophore, SE = submedian excavation of pygophore, SG = submedian groove on pygophore, SMN = submedian notch of pygophore, T_8 = tergite 8, T_9 = tergite 9.





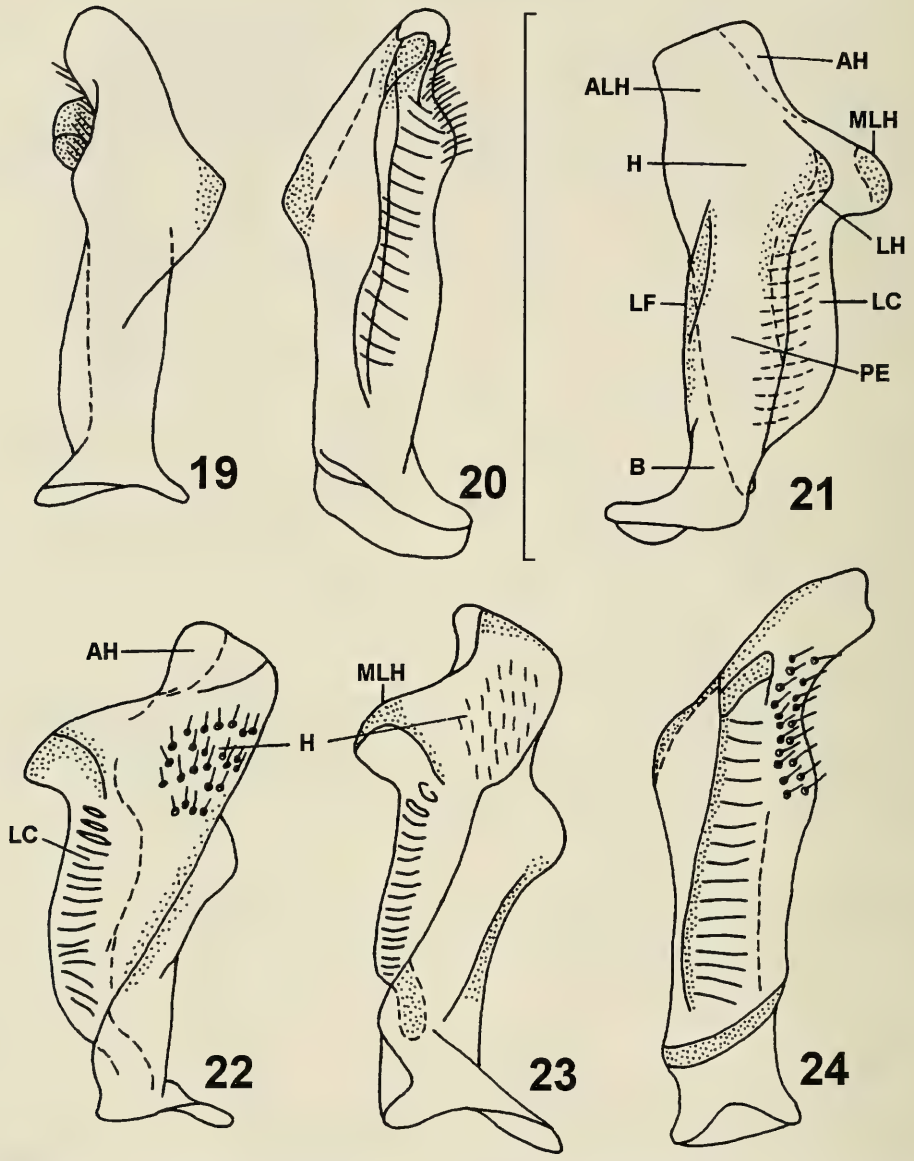




Figs. 15–18. 15, *Mezira froeschneri,* female terminalia, ventral view. 16–18, *M. granulata.* 16, Female terminalia, ventral view. 17, Left paramere, posterior view. 18, Left paramere, anterior view. Scale: 1.0 mm for Figs. 15, 16; 0.25 mm for Figs. 17, 18. Abbreviations: ALH = apical lobe of hypophysis, B = base, H = hypophysis, LC = longitudinal carina on peduncle, LF = longitudinal fold on peduncle, LG = median longitudinal groove on segment 9, LH = longitudinal fold on hypophysis, MLH = median lobe of hypophysis, P_8 = paratergite 8, P_9 = paratergite 9, PE = peduncle, S_7 = sternite 7, S = spiracle.

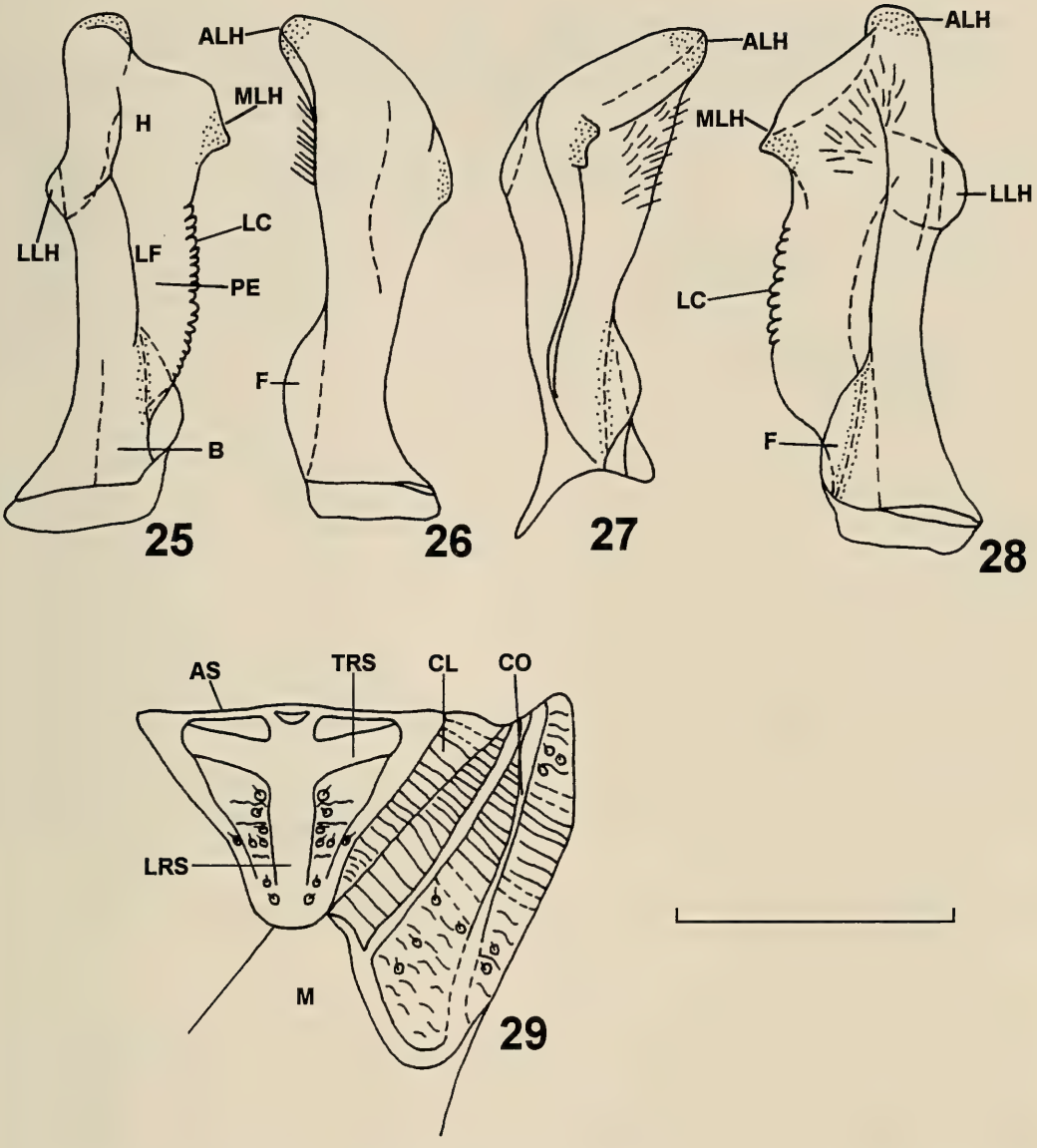
GBM (MHL); 6 ♂, 3 ♀, 2 April 1976, coll. CWO and GBM (MHL); 1 ♂, 5 ♀, 20 April 1976, coll. CWO and LDJ (MHL); 5 ♂, 8 ♀, 28 June 1976, coll. GBM and LDJ; 1 ♂, 2 ♀, 27 Oct. 1976, coll. LDJ (MHL); 1 ♂, 2 ♀, 6 Dec. 1976, coll. GBM (MHL).

The holotype and allotype will be deposited in the National Museum of Natural



Figs. 19–24. Left parameres. 19, 20, *Mezira granulata.* 19, Anterolateral view. 20, Posteromedial view. 21-24, *M. sayi.* 21, Posterior view. 22, Anterior view. 23, Anterolateral view. 24, Posteromedial view. Scale: 0.5 mm for all figs. Abbreviations: AH = lightly pigmented area of hypophysis, ALH = apical lobe of hypophysis, B = base, H = hypophysis, LC = longitudinal carina on peduncle, LF = longitudinal fold on peduncle, LH = longitudinal fold on hypophysis, MLH = median lobe of hypophysis, PE = peduncle.

History, Washington, DC (NMNH). Paratypes will be deposited in the NMNH; Department of Entomology Museum, University of Georgia, Athens; Florida State Collection of Arthropods, Gainesville; Purdue Entomological Research Collection, Purdue University, West Lafayette, Indiana; Snow Entomological Museum, University of Kansas, Lawrence; Louisiana State University Insect Collection, Lousiana State University, Baton Rouge; Department of Entomology, California Academy of Sciences,



Figs. 25–29. *Mezira froeschneri.* 25, Left paramere, posterior view. 26, Left paramere, anterolateral view. 27, Left paramere, posteromedial view. 28, Left paramere, anterior view. 29, Scutellum and base of wing. Scale: 1.0 mm for Fig. 29; 0.25 mm for Figs. 25-28. Abbreviations: ALH = apical lobe of hypophysis, AS = anterior margin of scutellum, B = base, CL = clavus, CO = corium, F = flange of base, H = hypophysis, LC = longitudinal carina on peduncle, LF = longitudinal fold on peduncle, LLH = lateral lobe of hypophysis, LRS = longitudinal ridge on scutellum, M = membrane, MLH = median lobe of hypophysis, PE = peduncle, TRS = transverse ridge on scutellum.

San Francisco; and the Entomology Collection, Southern Illinois University at Carbondale.

Other material examined.—FL: Santa Rosa Co.: 1 ♀ (originally as a paratype of *M. sayi*), 10.5 mi. NW Holt, Big Juniper River, 12 June 1974, coll. D. A. Hurd.

Etymology.—This species is named in honor of the American heteropterist, R. C. Froeschner.

Table 1. Measurements (mm)[a] of *M. froeschneri.*

Structure	Sex	Mean ± SE	Range
Body length	♂	4.98 ± 0.04	4.75–5.22
	♀	5.50 ± 0.08	5.18–5.87
Head length	♂	0.80 ± 0.01	0.76–0.84
	♀	0.83 ± 0.01	0.78–0.87
Width across eyes	♂	0.86 ± 0.01	0.82–0.89
	♀	0.94 ± 0.01	0.90–0.99
Width across postocular tubercles	♂	0.88 ± 0.01	0.84–0.94
	♀	0.97 ± 0.01	0.92–1.04
Antenniferous tubercle length	♂	0.20 ± 0.01	0.18–0.22
	♀	0.23 ± 0.00	0.20–0.25
Antennal segment lengths			
1	♂	0.34 ± 0.01	0.31–0.37
	♀	0.36 ± 0.01	0.32–0.39
2	♂	0.24 ± 0.00	0.24–0.26
	♀	0.27 ± 0.00	0.26–0.29
3	♂	0.41 ± 0.00	0.39–0.43
	♀	0.45 ± 0.01	0.43–0.47
4	♂	1.68 ± 0.02	1.60–1.80
	♀	1.77 ± 0.02	1.65–1.85
Pronotal length	♂	0.81 ± 0.01	0.78–0.86
	♀	0.91 ± 0.02	0.81–0.99
Pronotal width	♂	1.77 ± 0.02	1.67–1.87
	♀	1.85 ± 0.10	0.96–2.07
Scutellar basal width	♂	0.89 ± 0.00	0.86–0.91
	♀	0.99 ± 0.01	0.94–1.04
Scutellar length	♂	0.72 ± 0.01	0.68–0.76
	♀	0.81 ± 0.01	0.75–0.86
Pygophore length	♂	0.65 ± 0.01	0.61–0.68
Pygophore width	♂	0.73 ± 0.01	0.71–0.76
Pygophore depth	♂	0.58 ± 0.01	0.54–0.61

[a] N = 10 ♂, 10 ♀.

Specimens of Other Species Examined

Specimens of *M. granulata, M. novella,* and *M. sayi* examined are listed below. Collection abbreviations are as follows: LSU (Louisiana State University), NMNH (National Museum of Natural History), SIUC (Southern Illinois University at Carbondale), and SJT (Steven J. Taylor).

Mezira granulata.—Type material. Neotype: 1 ♂, MD, P.R. Uhler collection (NMNH). Other material examined: AR: 5 ♂, 7 ♀ (LSU); 1 ♂, 1 ♀ (SIUC); 28 ♂, 30 ♀ (SJT). IL: 10 ♂, 17 ♀ (SIUC). MD: 1 ♀, (NMNH). NC: 3 ♂, 4 ♀ (LSU); 2 ♀, (NMNH [P.R. Uhler Collection]); 7 ♂ (SIUC). OK: 1 ♀ (LSU).

Mezira novella (all material examined in Purdue University Collection, West Lafayette, IN).—Type material. Neotype: 1 ♂, "C. Sable Fla., W. S. B. Coll., 2-20-19; Purdue, Blatchley, Collection; Lectotype; *Mezira novella* Blachley (*sic*), Kormilev 81." The "lectotype" label is incorrect, as Blatchley (1924) designated a "type" specimen. However, Kormilev (1982b) stated that the type was lost and designated a neotype. We have added a label noting that this specimen is actually a neotype. Other material examined: FL: Monroe Co.: 2 ♂, 3 ♀, Cape Sable, 23 Feb. 1919, coll. W. S. Blatchley.

Mezira sayi.—Type material. Paratypes (all in collection of University of Georgia, Athens, GA): GA: Clarke Co.: 1 ♂, White-

hall Forest, sticky trap, 13-14 May 1976, coll. R. Turnbow; Franklin Co.: 1 ♂, 1 ♀, Tugaloo St. Pk., 10 May 1969, coll. A. Hamilton; Johnson Co.: 1 ♀, 1 mi. E Kite, 29 April 1977, coll. R. Turnbow; Oglethorpe Co.: 4 ♂, 3 ♀, Watkins Mill Bridge St. Pk., 6 April 1974, coll. D. A. Hurd & C. L. Smith. Other material examined: AR: 16 ♂, 14 ♀ (SJT). FL: 4 ♂, 2 ♀ (SJT). IL: 16 ♂, 21 ♀ (SIUC). LA: 25 ♂, 20 ♀ (LSU). MS: 1 ♂, 6 ♀ (LSU). NC: 10 ♂, 17 ♀ (SIUC). TX: 1 ♂ (SIUC); 16 ♂, 7 ♀ (SJT).

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TWO SPECIES OF *LEUCOPIS* MEIGEN (DIPTERA: CHAMAEMYIIDAE) PREDACIOUS ON THE RUSSIAN WHEAT APHID, *DIURAPHIS NOXIA* (MORDVILKO) (HOMOPTERA: APHIDIDAE), IN NORTH AMERICA

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Abstract.—Two species of *Leucopis* predacious on the Russian wheat aphid, *Diuraphis noxia* (Mordvilko), in North America are described. *Leucopis ninae* Tanasijtshuk is primarily known from the Palearctic Region, but has been recently introduced into the Nearctic. ***Leucopis gaimarii,*** n.sp., is endemic to the Nearctic Region.

Key Words: Chamaemyiidae, *Leucopis ninae, Leucopis gaimarii, Diuraphis noxia,* Russian wheat aphid

Two species of *Leucopis* Meigen (*s. str.*) (Diptera: Chamaemyiidae) preying on the Russian wheat aphid, *Diuraphis noxia* (Mordvilko) (Homoptera: Aphididae), in North America are described below. This publication is partly to provide names for further studies of these species. Their preimaginal stages have been studied by Gaimari (1993) and Gaimari and Turner (1996a, b). Efforts to introduce one species, the Palearctic *L. ninae,* into the Nearctic Region were undertaken by the USDA-APHIS-PPQ (Prokrym et al., in press). The other species is new to science and is endemic to the Nearctic Region, feeding on the introduced *D. noxia,* in addition to other aphid species.

Two *Leucopis* species other than *L. ninae* (*L. pallidolineata* Tanasijtshuk and *L. glyphinivora* Tanasijtshuk) are known to prey on *D. noxia* in the Palearctic Region (Tanasijtshuk 1986). *Leucopis pallidolineata* has been recorded only from the Palearctic, where it occurs from southern France to the Russian Far East. *Leucopis glyphinivora* is a Holarctic species widely distributed in the Palearctic, with Nearctic material also present in the National Museum of Natural History, Washington, DC, and the Canadian National Collection, Ottawa. Based on material in these collections, it is also widely distributed in the Nearctic. Both species are polyphagous, with the former recorded from 29 aphid species, and the latter from over 70.

Materials and Methods

The material of *L. ninae* was primarily from the collection of the Zoological Institute of the Russian Academy of Sciences in St. Petersburg, Russia, which houses over 600 specimens of this species, including the holotype and 36 paratypes. Additional material was collected by researchers from the USDA and Agriculture Canada from various sites in the Palearctic, including a series cultivated by S. D. Gaimari. The material for studies of the new Nearctic species was received from S. D. Gaimari.

Analysis of male genitalia is essential for accurate identification of most species of *Leucopis.* Specimens were relaxed, and their last abdominal segments were removed and soaked in 20% KOH for 24 hours. After rinsing, they were drawn through alcohol, xylene, oil of cloves, and

mounted in Canada balsam or stored in glycerin. Genitalia were separated from pregenital sclerites with probes, consisting of minutiae sharpened on a bar of marble and fixed to matchsticks. For closer examination and graphical representation of particular genitalic elements, some genitalia were further dissected.

Terminology follows that of McAlpine (1981). Following are some additional definitions and clarifications of terminology used in the present work. The term "ocellar plate" used in the description of the adult refers to an elevated area within the ocellar space, often extending forward through the anterior ocellus. The level of delimitation of this plate, its shape, size, and coloration may provide adequate taxonomic characters to distinguish some species of *Leucopis,* but not all of them. The OT (ocellar triangle) index represents the ratio of the distance between posterior ocelli and the distance between either posterior ocellus and the anterior ocellus. Frons width (when measuring its ratio to head width) is measured at the narrowest point, near the ocelli. Genal height is measured at the highest point. When evaluating frons coloration and abdominal spots, it should be noted that coloration may vary in intensity depending on angle of observation. Thus, abdominal spots clearly visible when inspected from behind may appear pale and even vanish when viewed from above.

Genitalic terminology basically conforms to McAlpine (1981) with the following exceptions: edite refers to the surstylus of McAlpine (1981), anterior paramere refers to the gonopod, posterior paramere refers to the gonostylus, and the phallus refers to the aedeagus.

Leucopis ninae Tanasijtshuk
(Figs. 1–10)

Leucopis ninae Tanasijtshuk 1966: 234; Tanasijtshuk, 1986: 272.

Male, female. Body length 1.8–2.8 mm. Body light grey.

Head 1.4–1.6 times as high as long. Frons widened anteriorly, 2.6–3.0 times narrower than head. Ocellar plate drop shaped, almost level with front surface; two dark grey or dark brown stripes enveloping ocellar plate, not fusing over lunule. Cigar shaped longitudinal stripe sometimes noticeable on plate with anterior ocellus located near center of stripe; dark swellings sometimes visible between anterior and posterior ocelli. OT index 1.1–1.3. Frontal vitta lightly hairy. Antenna and arista black; 3rd aristal segment 2.5–4.0 times longer than 2nd. Eye height 3.5–4.6 times longer than genal height. Row of minute bristles on each gena; fore bristle most conspicuous. Palpi black.

Mesonotum.—Golden brownish lateral stripes extending behind last pair of dorsocentral (dc) bristles; dark grey median stripes reach first pair of dc bristles. Spaces between stripes commonly devoid of bristles. Two pairs of dc bristles.

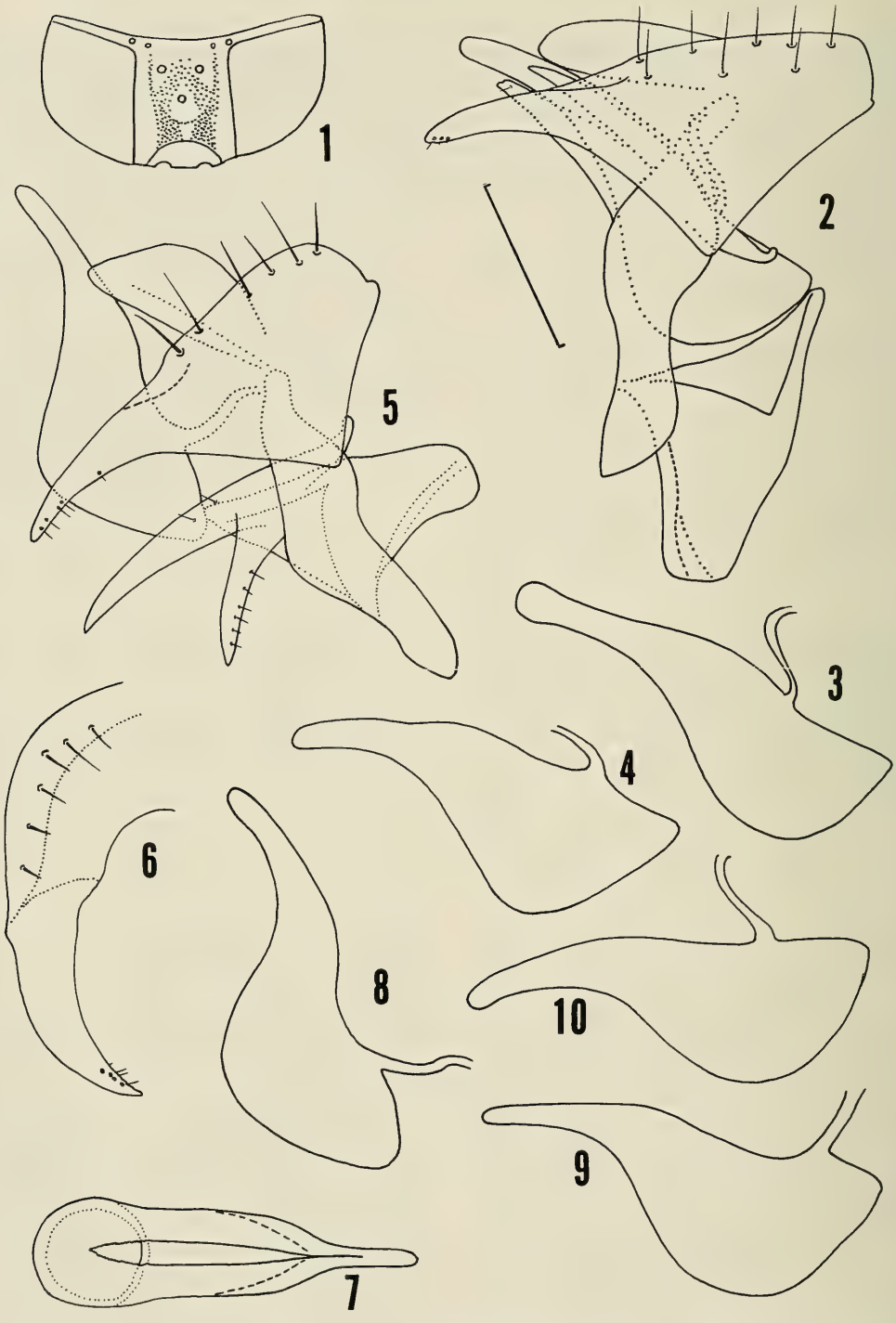
Legs.—Black; femoral apices, tibial bases, and certain tarsomeres yellow. 1st tarsomere on foreleg almost always completely yellow; middle and hind legs with at least two basal tarsomeres yellow.

Wing.—M and R 4+5 converging in the distal 1/3; ultimate section of Cu 1.1–1.3 times longer than m-cu.

Abdomen.—Syntergite 1+2 with grey spot covering at least 1/2. Two black spots on 3rd abdominal tergite, absent in some. Elongated dark regions of modified microtrichia present on lower edges of tergites 1+2 and 3.

Male genitalia (Figs. 1–10).—Epandrium with 5-10 pairs of large bristles posteriorly. Transfer to edites sharply outlined; edites narrow, relatively long in profile. Phallus swollen near base, smoothly tapering toward thick rounded apex.

Taxonomic notes.—The species is not identifiable by external appearance due to lack of sufficiently distinctive morphological characteristics and high variability in coloration. It is easily distinguishable using male genitalia, with its characteristically



Figs. 1–10. *Leucopis ninae*. 1, Head of male. 2, Male genitalia, holotype. 3, Variation of phallus, paratype. 4, Variation of phallus, Alma Ata (type-locality). 5, Male genitalia, Macedonia (specimen reared by Gaimari). 6, Same, edite from the front. 7, Same, phallus from below. 8, Variation of phallus, Macedonia. 9, Variation of phallus, Macedonia. 10, Variation of phallus, Montpelier, France.

shaped phallus which is expanded basally and has a thick rounded apex. However, genitalic characters are subject to high variability, which is evident from Figs. 2–10. In genitalic structure, *Leucopis impunctata* Roser is closest to *L. ninae*. Genitalic differences between these two species are negligible, but the species are readily differentiated by outward appearance.

Distribution.—Russia (North Caucasus), Ukraine, Transcaucasia (Armenia, Azerbaidjan), Kazakhstan (Holotype male and paratypes from the Askay farm, environs of Alma-Ata), Turkmenia, Uzbekistan, Tadjikistan, Kirghizia, Italy, Yugoslavia, Rumania, Turkey, Iraq, Iran, Afghanistan, Mongolia, and China. Introduced to USA (Arizona, California, Colorado, Idaho, Indiana, Kansas, Montana, Nebraska, New Mexico, Nevada, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, Wyoming) (Prokrym et al., in press) with unknown establishment. The species is well distributed in southern locations, but is not recorded north of 50° North Latitude.

Biology.—*Leucopis ninae* is one of the most common *Leucopis* species in the southern Palearctic. It inhabits highly variable biotopes ranging from deserts (Karakum, Kyzilkum) to mountain forests; however, it has not been recorded above 3000 m. It is commonly recorded from agrocenoses, and, along with *L. glyphinivora,* serves as a substantial component of the complex of entomophages in Middle Asia. The feeding range of the species is exceedingly wide. Despite the fact that its larvae are usually collected from aphids on angiosperms, they are also reported from adelgids, coccids and even psyllids (though in all probability they are feeding on aphids inhabiting the galls). Larvae of *L. ninae* are known to be predaceous on about 50 species.

Leucopis gaimarii Tanasijtshuk, new species

(Figs. 11–19)

Male, female. Body length 1.8–2.2 mm. Body light grey.

Head 1.5–1.65 times as high as long. Frons widened anteriorly, 2.5–3.0 times narrower than head. Ocellar plate nearly absent; plate not raised, distinguishable only by light grey coloration. Orbital welts light grey. Longitudinal dark grey stripes with blurred internal borders extending on sides of frontal vitta, converging above lunule. Light grey stripe passing through center of frontal vitta. Very short, light hairs conspicuous on frontal vitta and orbital welts. OT index 1.1–1.35. Ocelli of equal or nearly equal size, but sometimes anterior ocellus smaller than posterior ocelli. Antenna and arista black, 3rd aristal segment 3.5–4.5 times longer than 2nd, but at times this ratio is reduced to 2:1 (it seems likely that a mutation is responsible in such cases). Eye height 3.0–4.0 times longer than genal height. Row of minute bristles on each gena; one of the foremost bristles larger than others. Palpi black.

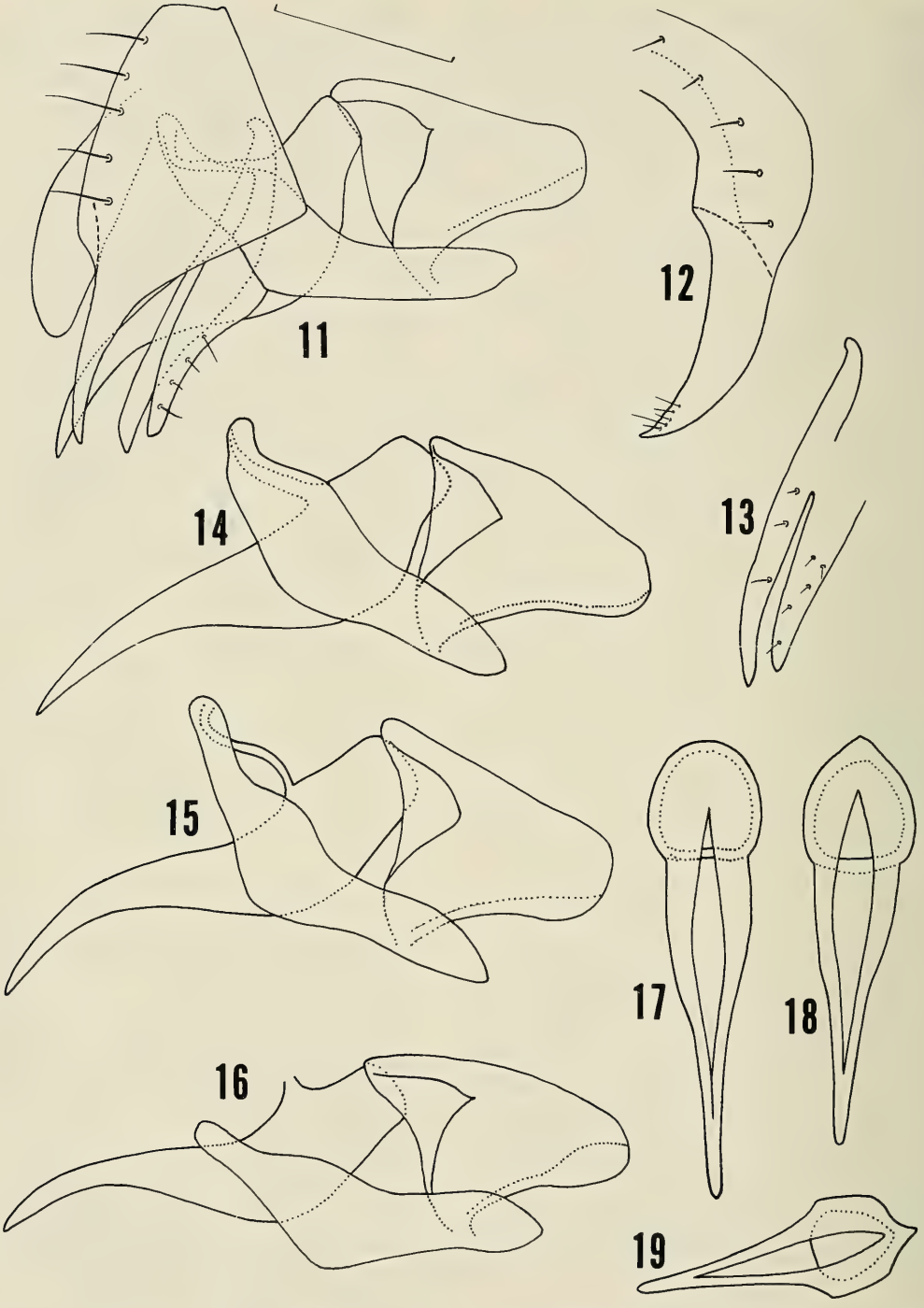
Mesonotum.—Lateral stripes of moderate width, dim brown, ending at posterior dc bristles. Dark grey median stripes extending over middle of mesonotum. Spaces between stripes devoid of bristles, at least to middle of mesonotum. Two pairs of dc bristles.

Legs.—Black; femoral apices, tibial bases, and certain tarsomeres yellow. First tarsomere on foreleg almost always completely yellow; middle and hind tarsi with 2–3 basal tarsomeres yellow.

Wing.—M and R 4+5 parallel or slightly converging in distal 1/2; ultimate portion of Cu 1.4–1.6 times longer than m-cu, sometimes ratio increased to 1.8:1.

Abdomen.—Syntergite 1+2 with dark grey spot, occupying nearly 2/3. Two grey spots with blurred borders may be present on 3rd tergite along with grey median longitudinal dots on 4th and 5th tergites. Spots and dots on tergites 3–5 may vary from pale to absent. Elongated dark regions of modified microtrichia present on lower edges of tergites 1+2 and 3.

Male genitalia (Figs. 11–19).—Epandrium with thin edites in profile, 5–7 pairs



Figs. 11–19. *Leucopis gaimarii,* male genitalia. 11, General view, Garfield Co. 12, Same, edite from the front. 13, Same, parameres from below. 14, Variation of genitalia without epandrium and parameres, Garfield Co. 15, Variation of genitalia, Asotin Co. 16, Variation of genitalia, Asotin Co. 17, Phallus from below, Garfield Co. 18, Same, inclined. 19, Phallus, Asotin Co., strongly inclined.

of large bristles may be present on posterior surface of epandrium. In posterior view, edites appear significantly wider. Shape of hypandrium highly variable even within single population. Posterior parameres slightly longer than anterior ones. Shape of phallus distinctive, with relatively wide, nearly rectangular base in profile. In posterior and ventral views, characteristic constriction conspicuous (Figs. 17–19).

Taxonomic notes.—*Leucopis gaimarii* is widely variable in some parameters, such as the disappearance of spots on tergites 3–5 in many specimens, the shape of the hypandrium in profile, and the rounded or angular cut of the aedeagal apodeme. This variability is all the more remarkable because it is recorded within series cultivated in the laboratory and originated from common ancestors. It illustrates the concept of high intraspecific variability in *Leucopis*. In genitalic structure this species is closest to the Palearctic species *L. pallidolineata* Tanasijtshuk and especially *L. cerasiphila* Gomolitzkaja and Tanasijtshuk, but both of these Palearctic species differ from *L. gaimarii* in having a distinct ocellar plate. *Leucopis gaimarii* is also distinguished from *L. pallidolineata* by the darker lateral stripes of the mesonotum, presence of dark spots on the 3rd abdominal tergite (a character found in only part of the series of *L. gaimarii*), and the more rounded base of the phallus in *L. pallidolineata.* The genitalic structure in *L. cerasiphila,* particularly the shape of phallus, is similar to that in *L. gaimarii,* and a basic difference is the sharply pronounced ocellar plate in *L. cerasiphila.*

It seems plausible to make no distinction between these species on the grounds of similarity in genitalia; however, a serious barrier lies in the different structure of the ocellar plate as well as the fact that their habitats differ widely in ecological and geographical characteristics. *Leucopis gaimarii* is distributed northward at least to the state of Washington, and may possibly inhabit southern Canada as well. *Leucopis cerasiphila* possesses quite a limited distributional area. It has been collected only in small numbers in Turkmenia and Southern Tadjikistan, and is not reported from the vast collections gathered in Siberia, the Russian Far East, and Mongolia. Based on genitalic similarities and external morphology, I believe *L. cerasiphila* and *L. gaimarii* to be sister species, evidently originating due to geographic isolation. Without doubt both these species are near to *L. pallidolineata.*

Distribution.—Washington, Idaho and Utah, though the true distribution of this species is probably much wider.

Types.—Holotype: ♂, Prep. #7058, Washington, Asotin Co., 0.6 km west Anatone (on Mill Road), 1160 m, Aug. 1991, ex: swept off *Diuraphis noxia* infested wheat, *Triticum aestivum,* reared Mar. 1992, collector S. D. Gaimari. Deposited in the Illinois Natural History Survey, Urbana, IL. Paratypes: 33 ♂s, 35 ♀s, 12 ♂s with puparia, 16 ♀s with puparia, collected and reared with holotype; 51 ♂s, 78 ♀s, 9 ♂s with puparia, 24 ♀s with puparia, collected and reared from Washington, Garfield Co., Central Ferry, USDA-ARS Research Farm, 165 m, Jul. 1991, ex: swept off *Diuraphis noxia* infested cereal ryegrass, *Secale cereale,* reared Feb. 1992, collector S. D. Gaimari; 1 ♂, Washington, Lake Paha, 20.VII (19)20, collector R. C. Shannon; 1 ♂, Idaho, Moscow, 8.VIII (19)39, rotary trap, collector T. A. Brindley. 1 ♂, Utah, Salt Lake (City), 7.III (19)12, reared on aphids on *Elymus* leaves. Deposited in the Illinois Natural History Survey, the National Museum of Natural History, Washington, DC, the Zoological Institute of the Russian Academy of Sciences, St. Petersburg, and the Maurice T. James Entomological Collection, Washington State University, Pullman.

Biology.—The specimens reared in Asotin County were preying on *Diuraphis noxia* from *Triticum aestivum.* The specimens from Garfield County were on *D. noxia* from *Secale cereale.* The specimen from Salt Lake City was also reared on aphids from a graminaceous plant, *Elymus.*

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IMMATURE STAGES OF *LEUCOPIS NINAE* TANASIJTSHUK AND TWO VARIANT POPULATIONS OF *LEUCOPIS GAIMARII* TANASIJTSHUK (DIPTERA: CHAMAEMYIIDAE) FEEDING ON RUSSIAN WHEAT APHID, *DIURAPHIS NOXIA* (MORDVILKO) (HOMOPTERA: APHIDIDAE)

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Abstract.—The present difficulty in identifying adult specimens of *Leucopis* points to a need for additional methods. Characters of the immature stages may be important in this regard, at least for separating certain species and species complexes, although this study indicates possible populational plasticity in one species. Immatures may also be important for systematic studies at higher taxonomic levels. Three populations within *Leucopis* (*s. str.*), including *L. ninae* Tanasijtshuk and two distinct populations of *L. gaimarii* Tanasijtshuk, were found to have reliable characteristics to distinguish them in all immature stages. The characters include the pattern of longitudinal ridges and the structure of pores in the chorionic latticework of eggs, the cephalopharyngeal skeleton morphology and the patterns of surface sculpturing of larvae (any instar) and puparia. The most important characters for larvae and puparia involve the size, density, definition, and contiguity of chaetoids (fleshy, seta-like projections of the integument) covering the body.

Key Words: Chamaemyiidae, *Leucopis,* morphology of immatures

Flies of the family Chamaemyiidae have been recognized as important predators on sternorrhynchous homopterans. However, they are poorly known morphologically in the immature stages, and the adults have been unevenly studied, with the majority of descriptions coming from the Palearctic Region (Tanasijtshuk 1990). There has been little large-scale taxonomic work on the family, except for the revision of the genus *Neoleucopis* Malloch (McAlpine 1971), the revision of the mainly Nearctic genus *Pseudodinia* Coquillett (Barber 1985), and the numerous papers of Tanasijtshuk (especially 1986) for the Palearctic Region. Identifying adults to species is difficult due to their small size (1.0–4.0 mm) and similar external morphology. Features of the male genitalia have been used extensively (Barber 1985, Bennett 1961, McAlpine 1960, 1967, 1971, 1978, McAlpine and Tanasijtshuk 1972, Smith 1963, Tanasijtshuk 1961, 1962, 1965, 1966, 1968a, b, 1970, 1972, 1986, 1996a, b, Tawfik 1966), but there may also be useful characters in the immature stages, and there is an obvious need for associating adults with their respective immatures. This study serves to associate the immature stages and adults of two species, *L. ninae* Tanasijtshuk and *L. gaimarii* Tanasijtshuk, discussed in Gaimari (1993), Gaimari and Turner (1996), and Tanasijtshuk (1996b).

There are detailed descriptions of imma-

ture stages for only a small percentage of the known chamaemyiid species. The following is a synoptic list of the detailed descriptions for the immature stages of the Chamaemyiidae: *Chamaemyia flavipalpis* (Haliday) (Raspi 1983), *C. polystigma* Meigen (Sluss and Foote 1973), a *Leucopis* sp. nr. *albipuncta* Zetterstedt (Tracewski 1983), *L. americana* Malloch (Brown and Clark 1956 [as *Leucopina*]), *L. conciliata* McAlpine and Tanasijtshuk (McAlpine and Tanasijtshuk 1972), *L. interruptovittata* Aczél (Raspi 1983), *L. verticalis* Malloch (Sluss and Foote 1971), *Neoleucopis obscura* (Haliday) (Brown and Clark 1956, Trägårdh 1931), *N. pinicola* Malloch (Clark and Brown 1957, Sluss and Foote 1973 [as *L.* (*N.*) *pinicola*]), *Parochthiphila coronata* (Loew) (Raspi 1983), and *Pseudodinia pruinosa* Melander (Barber 1985). The morphology of eggs has been described for *Chamaemyia flavipalpis* (Haliday) and *Parochthiphila coronata* (Loew) (Mazzini and Raspi 1983), and generally for *Leucopis* Meigen, *Chamaemyia* Panzer, *Parochthiphila* Czerny, and *Acrometopia* Schiner (Tanasijtshuk 1974). Additionally, Bennett (1961), Maple (1934), and Tanasijtshuk (1959) discussed the immature stages for several *Leucopis* species, and Ferrar (1987) provides a synopsis of descriptions, including partial descriptions for the immatures of some species in the family. The following descriptions will add to the morphological information on the immature stages of *Leucopis*. They will also provide a partial framework of characters for systematic studies necessary for distinguishing genera, species groups, and species in the various immature stages.

Materials and Methods

Three populations of *Leucopis* (*s. str.*) were used in this study: *L. ninae* from Skopje, Macedonia (approximately 42°N 21°E), and two populations of *L. gaimarii* from eastern Washington. The 'Central Ferry' population of *L. gaimarii* (*L.* sp. #1 of Gaimari 1993) originated in Washington, Garfield County, Central Ferry, USDA-ARS Research Farm (46°37′N 117°49′W; elevation 195 m), swept in July 1991 from cereal ryegrass, *Secale cereale* Linnaeus (Poaceae), infested with Russian wheat aphid, *Diuraphis noxia* (Mordvilko) (Homoptera: Aphididae). The 'Anatone' population of *L. gaimarii* (*L.* sp. #2 of Gaimari 1993) originated in Washington, Asotin County, 0.6 km west Anatone (46°08′N 117°08′W; elevation 1160 m), swept in August 1991 from *D. noxia*-infested wheat, *Triticum aestivum* Linnaeus (Poaceae). Tanasijtshuk (1966, 1986, 1996b) discussed the adult stage of *L. ninae* and provided figures of the male terminalia, and *L. gaimarii* is described for the first time in Tanasijtshuk (1996b).

Specimens of all life stages and instars of the three populations were obtained from living cultures in the Northwest Biological Control Insectary and Quarantine facility at Washington State University. Information on the origins and maintenance of these colonies can be found in Gaimari (1993). The present work describes the morphology in all immature stages and instars of *L. ninae* and both populations of *L. gaimarii*. Morphological data not repeated in the description of *L. gaimarii* (using the 'Central Ferry' population as the standard) are the same as in *L. ninae*. Differences between the two populations of *L. gaimarii* are noted in the text, i.e. variations and figures of the 'Anatone' population are set off in brackets.

Live larvae ($n > 150$) were measured daily to provide a full size range for each instar. Because they extend and retract during movement, we adopted a standardized method for measurement where each larva was measured when fully extended to determine the maximum body length.

For scanning electron microscope study, specimens were prepared in the following manner. All immature stages were killed in 70% ethyl alcohol. Eggs and larvae were dehydrated through an ethanolic step series, increasing the concentration of alcohol by five percent every eight hours until reaching 100%. Specimens remained in 100% ethyl alcohol for at least eight hours before

being desiccated under CO_2 in a critical point dryer. This reduced the distortion that normally occurs when soft-bodied specimens are preserved in ethyl alcohol (Postek et al. 1980, Stehr 1987). Puparia were sufficiently sclerotized to be air dried without distortion. Specimens were attached to stubs using double-stick tape and plasma sputter coated with a 30 nm gold layer. Images were photographed through the microscope running at an accelerating voltage of 20 kV. Gaimari (1994) found that live puparia were able to survive the harsh conditions within the plasma sputter coater and the scanning electron microscope.

Larval cephalopharyngeal skeletons were acquired from larval exuviae, eclosed puparia, and living specimens. Larval exuviae and puparia were placed in glycerin on a drop-center slide and viewed under phase-contrast microscopy. Living larvae were killed and preserved in 70% ethyl alcohol. The integument was cleared by cutting the larva in half and soaking the anterior end in cold 10% sodium hydroxide overnight. The specimens were then rinsed for 10 minutes with water and acidified in a 0.5–1.0% acetic acid solution for one hour. Any remaining tissue around the skeleton was teased out under a dissecting microscope. The cephalopharyngeal skeletons were transferred into glycerin on a drop-center slide and viewed as above, and drawn with the help of a camera lucida.

Morphology and Terminology

Basic terminology for morphology is according to Teskey (1981). The following are some definitions and clarifications of terminology used in the present work.

In reference to larval and puparial segmentation, we refer to the thoracic segments as 1–3, and the abdominal segments as I–VIII, anterior to posterior. Ranges and means are given in the form "range, mean," e.g. 0.11–0.16, 0.14 mm.

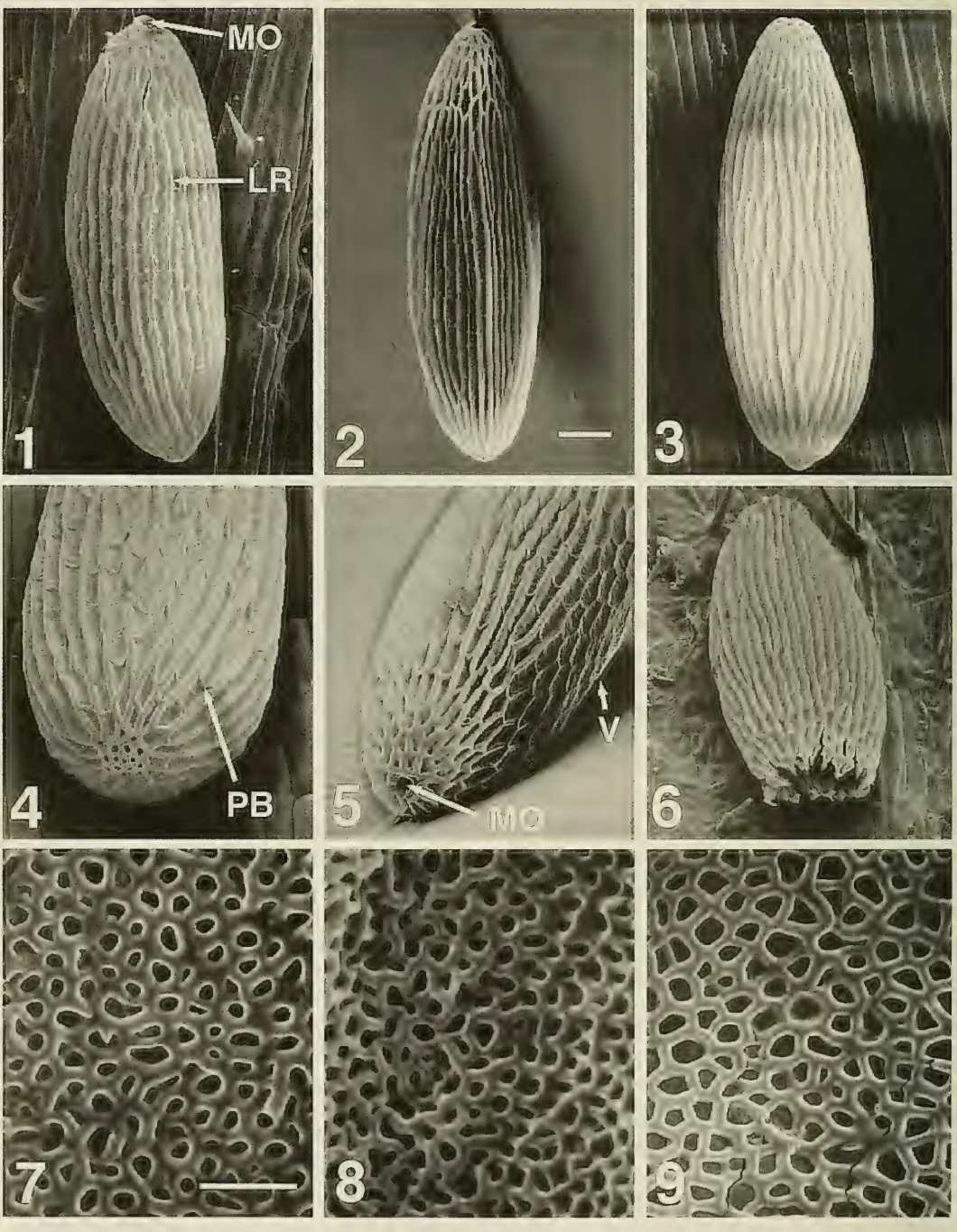
The posterior end of the egg has numerous openings (Fig. 4) of as yet unknown function. Some authors (Barber 1985, Mazzini and Raspi 1983, Tanasijtshuk 1974, Tracewski 1983) have suggested that these openings represent micropyles. However, Ferrar (1987) points out that in the cyclorrhaphous Diptera, the micropyles are always at the anterior pole of the egg, which is the eclosion end. This is consistent with earlier interpretations by Sluss and Foote (1971, 1973) in their treatments of the Chamaemyiidae.

Chaetoids are fleshy, seta-like projections of the larval integument (e.g. Figs. 18–26). They vary among species, and among instars, as to their contiguity, density, size, and definition. Measurement of "chaetoid density" on the anterior and posterior pseudosegments of segment III was accomplished by using the enlarged chaetoid row of the middle pseudosegment (as in Fig. 19) as a frame of reference; the middle four set off the area counted.

Results

Egg

Leucopis ninae.—Length 0.47–0.57, 0.52 mm ($n > 50$); maximum width 0.17–0.22, 0.20 mm; live color off-white to white; subcylindrical; posterior end bluntly rounded; anterior end slightly tapered (Fig. 1); posterior end with 5–14 openings (as in Fig. 4), each encircled by a ring of small pores; anterior end with single, rounded micropylar opening (as in Fig. 5); chorion highly sculptured (Fig. 1), dorsum convex, with longitudinal ridges distinct and subparallel; 13–15 ridges visible at widest portion of dorsal aspect; perpendicular connective bridges join major ridges (as in Fig. 4); ridges within transverse median area commonly anastamosing, posterior end with frequent anastamosing, anterior end with hexagonal arrangement; venter slightly flattened, with similar hexagonal arrangement, except medially, where it becomes less pronounced (as in Fig. 5); eclosed egg with opening irregular and jagged (as in Fig. 6) due to first instar tearing chorion with mouth hooks to escape; pores of chorionic lattice-



Figs. 1–9. Egg stage. 1, *Leucopis ninae,* dorsal. 2, *L. gaimarii* 'Central Ferry,' dorsal (scale bar = 0.05 mm). 3, *L. gaimarii* 'Anatone,' dorsal. 4, *L. gaimarii* 'Anatone,' anterior. 5, *L. gaimarii* 'Central Ferry,' posterior. 6, *L. gaimarii* 'Anatone,' anterior, post-eclosion. 7, *L. ninae,* chorionic latticework (scale bar = 2.0 μm). 8, *L. gaimarii* 'Central Ferry,' chorionic latticework. 9, *L. gaimarii* 'Anatone,' chorionic latticework. Abbreviations: LR = longitudinal ridge; MO = micropylar opening; PB = perpendicular connective bridge; V = venter.

work (Fig. 7) possibly represent aeropyles (Tanasijtshuk 1974), usually not as wide as inter-pore distance, smooth and rounded; pore diameter 0.20–0.60, 0.42 μm (n > 50 pores); over 20 pores per 10 μm^2 area.

Leucopis gaimarii.—Length 0.45–0.55, 0.52 [0.42–0.52, 0.47] mm (n > 50); maximum width 0.15–0.22 [0.16–0.20], 0.19 mm; chorion (Fig. 2 [3]) with 14–17 [13–15] longitudinal, dorsal ridges visible at widest portion of dorsal aspect; ridges within transverse median area closely parallel and unbranched [subparallel and commonly anastamosing]; pores of chorionic latticework (Fig. 8 [9]) smaller and rounded [with angular appearance], usually slightly wider than inter-pore distance; pore diameter 0.10–0.40, 0.26 [0.30–0.90, 0.51] μm (n > 50 pores); over 30 [20] pores per 10 μm^2 area.

First Larval Instar

Leucopis ninae.—Length 0.50–1.25 mm (n > 100); maximum width 0.20–0.35 mm; whitish to slightly translucent with sparse, milky-white globules under integument; darkened gut material visible through integument in fed individuals; body segments (in all larval instars and puparium) variously studded with chaetoids.

Dorsally (Fig. 10), larva fusiform, tapered more anteriorly than posteriorly; narrowed posteriorly from segments V–VIII and anteriorly from segments IV–1; largest segments (IV and V) subequal in size; segmentation clearly visible; segments 2–VII divided into 3 pseudosegments by secondary annulations (Fig. 18); middle pseudosegment (Fig. 18) with transverse row of 6 distinctly enlarged chaetoids (labeled in Fig. 19); additional enlarged chaetoid isolated beyond lateral end of row (Fig. 18); middle pseudosegment not extended laterally beyond dorsal aspect, but appears enclosed by anterior and posterior pseudosegments; anterior and posterior pseudosegments with numerous, small, poorly-defined, separated chaetoids; chaetoid density (as defined in Morphology and Terminology) 18–22, 19 chaetoids (n > 10).

Laterally (as in Fig. 13), tapering consistent with dorsal aspect; pseudosegmentation not apparent; segments 2–VII with small chaetoids extending slightly beyond large chaetoid row of middle pseudosegment of dorsal aspect (Fig. 29); distinct swelling with central pit visible beyond large chaetoid row; tubercles dorsad and ventrad to swelling indistinct; low, creeping welt-like mounds arise ventral to swelling on segments 3–VII.

Cephalic segment fully retractable (as in Fig. 49); antennal papillae distinct and elongated; maxillary sensory papillae evident beneath as pair of large disks, separated by vertical, median groove; pair of small papillae arise below these and lateral to preoral cavity; cephalopharyngeal skeleton as in Fig. 38; gular region with incomplete U-shaped collar or cephalic ring (Bennett 1961, Gaimari 1993, Hennig 1952, Maple 1934, Smith 1989).

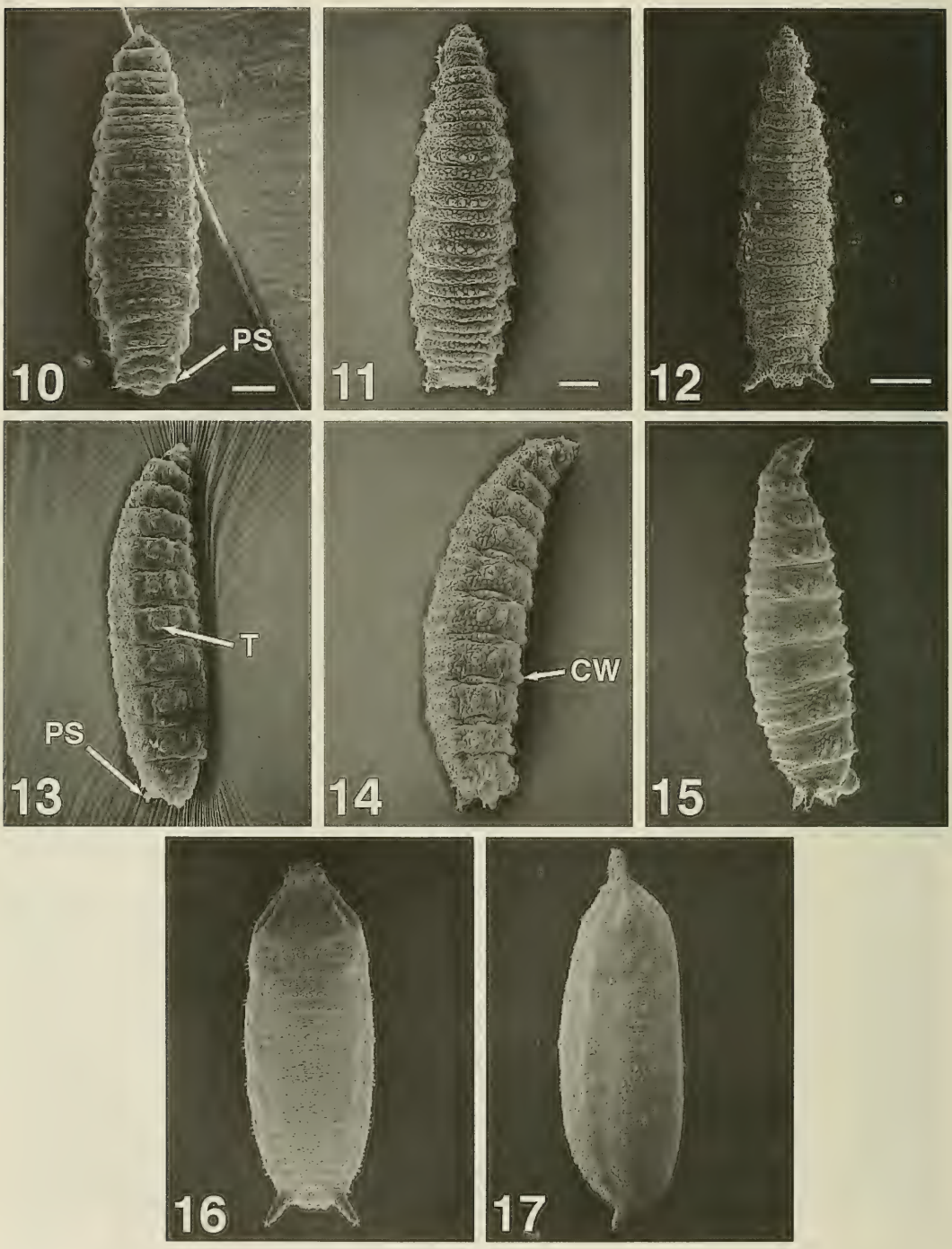
Anterior spiracles absent; posterior spiracles on short, tubular stalks, slightly diverging at posterolateral corners of tergite VIII (Fig. 62); each bilobed with transverse, distal slit on each lobe (as in Fig. 53).

Segment VIII divided dorsally into 2 pseudosegments, each with few, poorly-defined, small chaetoids (Fig. 62); posterior pseudosegment with about 20 chaetoids between posterior spiracular processes; caudal area with 2 small, indistinct chaetoids above and between paired, projecting tubercles; anus situated below.

Leucopis gaimarii.—Length 0.55–1.25 [0.50–1.25] mm (n > 100); maximum width 0.15–0.35 [0.15–0.30] mm.

Dorsally, anterior and posterior pseudosegments with numerous, small, poorly-defined [well-defined], contiguous (pattern appearing braided) chaetoids (Fig. 19 [20]); chaetoid density 20–24, 22 [13–17, 15] chaetoids (n > 10).

Laterally [Fig. 13], swelling with enlarged tubercles: 1 dorsad (consisting of 2 enlarged, fused chaetoids) and 1 ventrad to pit (Fig. 30 [31]).



Figs. 10–17. Larval and puparial habitus. 10, *Leucopis ninae,* dorsal first instar (scale bar = 0.1 mm). 11, *L. gaimarii* 'Central Ferry,' dorsal second instar (scale bar = 0.1 mm). 12, *L. gaimarii* 'Anatone,' dorsal third instar (scale bar = 0.5 mm). 13, *L. gaimarii* 'Anatone,' lateral first instar. 14, *L. gaimarii* 'Central Ferry,' lateral second instar. 15, *L. ninae,* lateral third instar. 16, *L. ninae,* dorsal puparium. 17, *L. gaimarii* 'Central Ferry,' lateral puparium. Abbreviations: CW = creeping welt; PS = posterior spiracle; T = tubercle.

Cephalopharyngeal skeleton as in Fig. 39 [40].

Segment VIII with posterior pseudosegment having about 25 [20] small, well-defined chaetoids between posterior spiracular processes (Fig. 63).

Second Larval Instar

Leucopis ninae.—Length 1.30–2.50 mm (n > 100); maximum width 0.30–0.70 mm; whitish to slightly translucent with scattered, milky-white globules beneath integument; blackened gut visible through integument.

Dorsally (as in Fig. 11), larva similar to first instar, except narrowed posteriorly from segments VI–VIII and anteriorly from segments IV–1; largest segments (IV–VI) subequal in size; middle pseudosegment (Fig. 21) with scattered, small, poorly-defined chaetoids and transverse row of 6 elongated, spinule-like chaetoids protruding from low, disk-like elevations; additional spinule-like chaetoid isolated beyond lateral end of row; middle pseudosegment not extended laterally beyond dorsal aspect, but appears enclosed by anterior and posterior pseudosegments; anterior and posterior pseudosegments with scattered, small, poorly-defined, separated chaetoids; chaetoid density 16–21, 18 chaetoids (n > 10).

Laterally (as in Fig. 14), tapering consistent with dorsal aspect; pseudosegmentation not apparent; segments 2 and 3 each with 3 elongated, spinule-like chaetoids in triangular arrangement (as in Fig. 56); segments I–VII each with lateral swelling bearing central pit and sparse, small, poorly-defined chaetoids (Fig. 32); swelling with 2 spinule-like chaetoids dorsad and 1 ventrad to pit, also visible in dorsal aspect.

Ventrally (Fig. 32), 3 pseudosegments evident on segments 2–VII; posterior pseudosegment with large, paired, creeping welt-like mounds; anterior pseudosegment with smaller, second pair of mounds placed medially to larger mounds; middle pseudosegment with elongated, spinule-like, ventrolateral chaetoid beneath ventrolateral pit.

Cephalic segment (Fig. 50) as in 1st instar, except maxillary sensory papillae evident as a pair of small, raised disks, separated by vertical, median groove; pair of larger papillae below these and laterad to preoral cavity; cephalopharyngeal skeleton as in Fig. 41; gular region with incomplete, U-shaped collar or cephalic ring (Fig. 42).

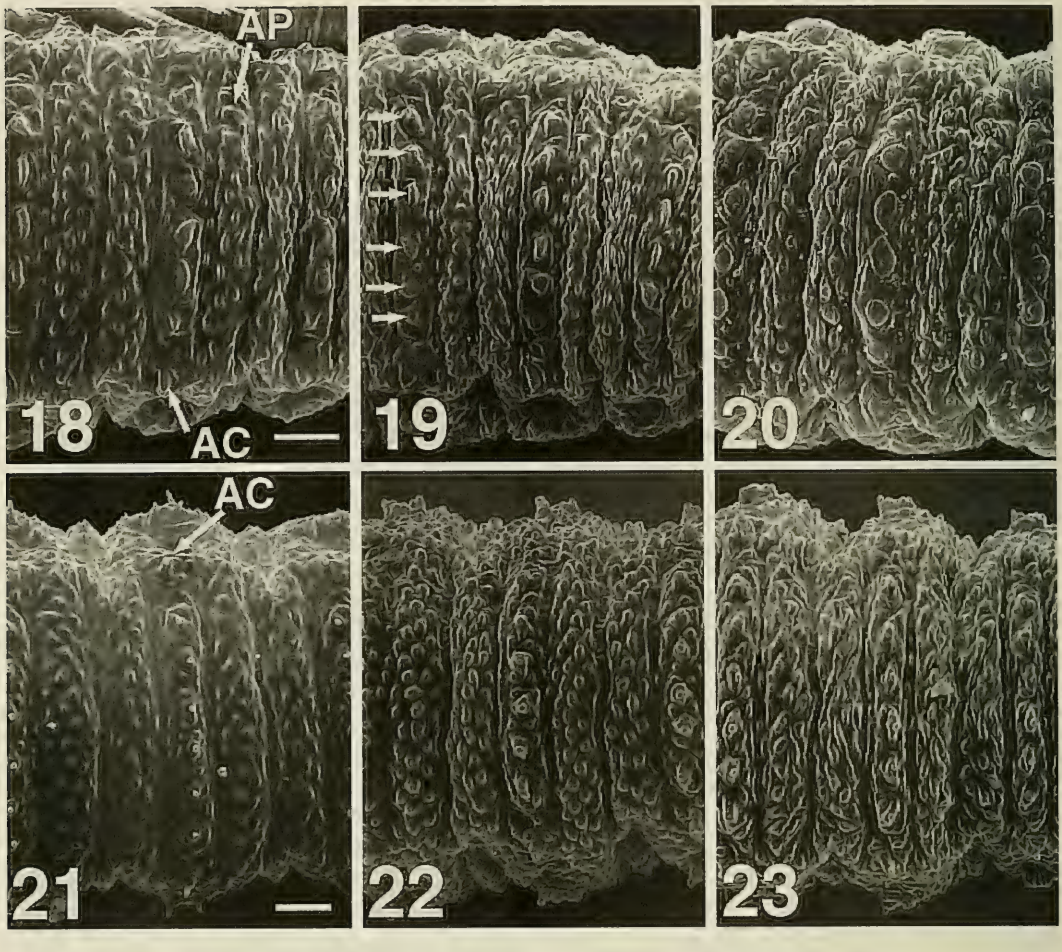
Anterior spiracles directed forward from posterolateral portion of segment 1 (as in Fig. 56); each 3 or 4 lobed, or mixed, spread fan-like with single, transverse, distal slit in each lobe; single, circular opening (probably the ecdysial scar) basal to lobes and posterior on spiracular base; posterior spiracle trilobed, mounted on a raised, quadrangular prominence with short, wide base (Fig. 54); base covered with small chaetoids, similar to those of dorsal aspect; lobes each bearing single, transverse, distal slit; single, circular opening (probably the ecdysial scar) basal to lobes.

Segment VIII deeply divided dorsally into 2 pseudosegments, each with small, scattered chaetoids (Fig. 64); posterior pseudosegment with about 14 small, poorly-defined chaetoids between posterior spiracular processes; laterally, 3 elongated, spinule-like chaetoids present in triangular arrangement; caudal area with few chaetoids, except for 2 small chaetoids above and between paired, projecting tubercles. Anus situated below.

Leucopis gaimarii.—Length 1.15–2.55 [1.05–2.45] mm (n > 100); maximum width 0.25–0.65 [0.20–0.60] mm.

Dorsally (Fig. 11), middle pseudosegment with scattered, small, well-defined [poorly-defined] chaetoids and transverse row of 6 enlarged, well-defined [poorly-defined], stubby chaetoids; additional enlarged, stubby chaetoid beyond lateral end of row; anterior and posterior pseudosegments with numerous, small, crowded (but separated) [contiguous (pattern appearing braided)], well-defined [poorly-defined] chaetoids (Fig. 22 [23]); chaetoid density 20–25, 23 [18–21, 20] chaetoids (n > 10).

Laterally [Fig. 14], segments 2 and 3 each with 3 enlarged, stubby chaetoids in



Figs. 18–23. Segment III, dorsal (anterior to right). 18, *Leucopis ninae,* first instar (scale bar = 0.05 mm). 19, *L. gaimarii* 'Central Ferry,' first instar. 20, *L. gaimarii* 'Anatone,' first instar. 21, *L. ninae,* second instar (scale bar = 0.05 mm). 22, *L. gaimarii* 'Central Ferry,' second instar. 23, *L. gaimarii* 'Anatone,' second instar. Abbreviations: AC = additional enlarged chaetoid beyond lateral end of row; AP = anterior pseudosegment; unlabelled arrows = enlarged chaetoid row of middle pseudosegment of segment IV.

triangular arrangement (Fig. 56); lateral swelling with 2 enlarged, stubby chaetoids on raised area dorsad and 1 ventrad to pit, also visible in dorsal aspect; swelling with dense [sparse], small, well-defined [poorly-defined] chaetoids (Fig. 33 [34]).

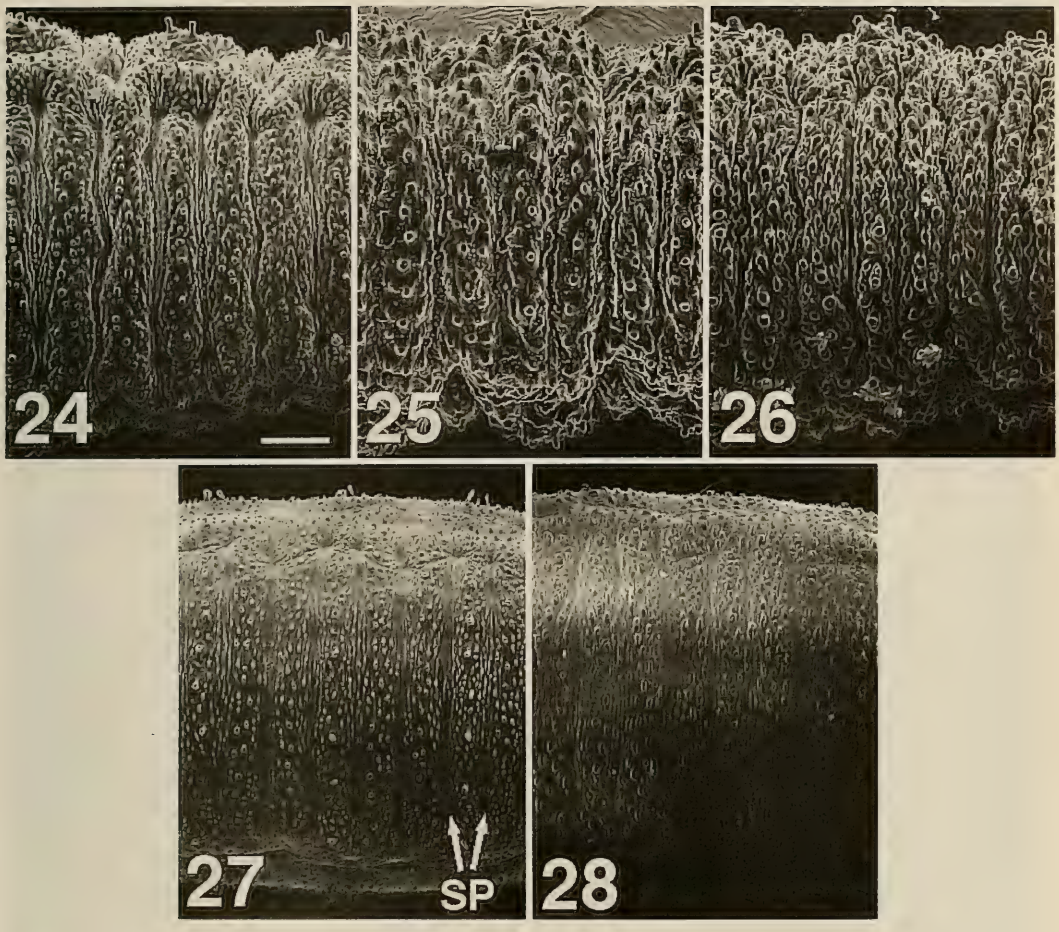
Ventrally, pseudosegmentation faint; middle pseudosegment with enlarged, stubby, ventrolateral chaetoid beneath ventrolateral pit (Fig. 33 [34]).

Cephalopharyngeal skeleton as in Fig. 43 [44]; gular region as in *L. ninae.*

Segment VIII with posterior pseudosegment having about 25 [20] small, well-defined, crowded [contiguous] chaetoids between posterior spiracular processes (Fig. 65); laterally, 3 enlarged, stubby chaetoids present in triangular arrangement.

Third Larval Instar

Leucopis ninae.—Length 2.35–4.25 mm ($n > 100$); maximum width 0.55–1.20 mm; slightly translucent with many milky-white globules under integument, giving body white appearance; black gut contents visible through integument, especially posteriorly.



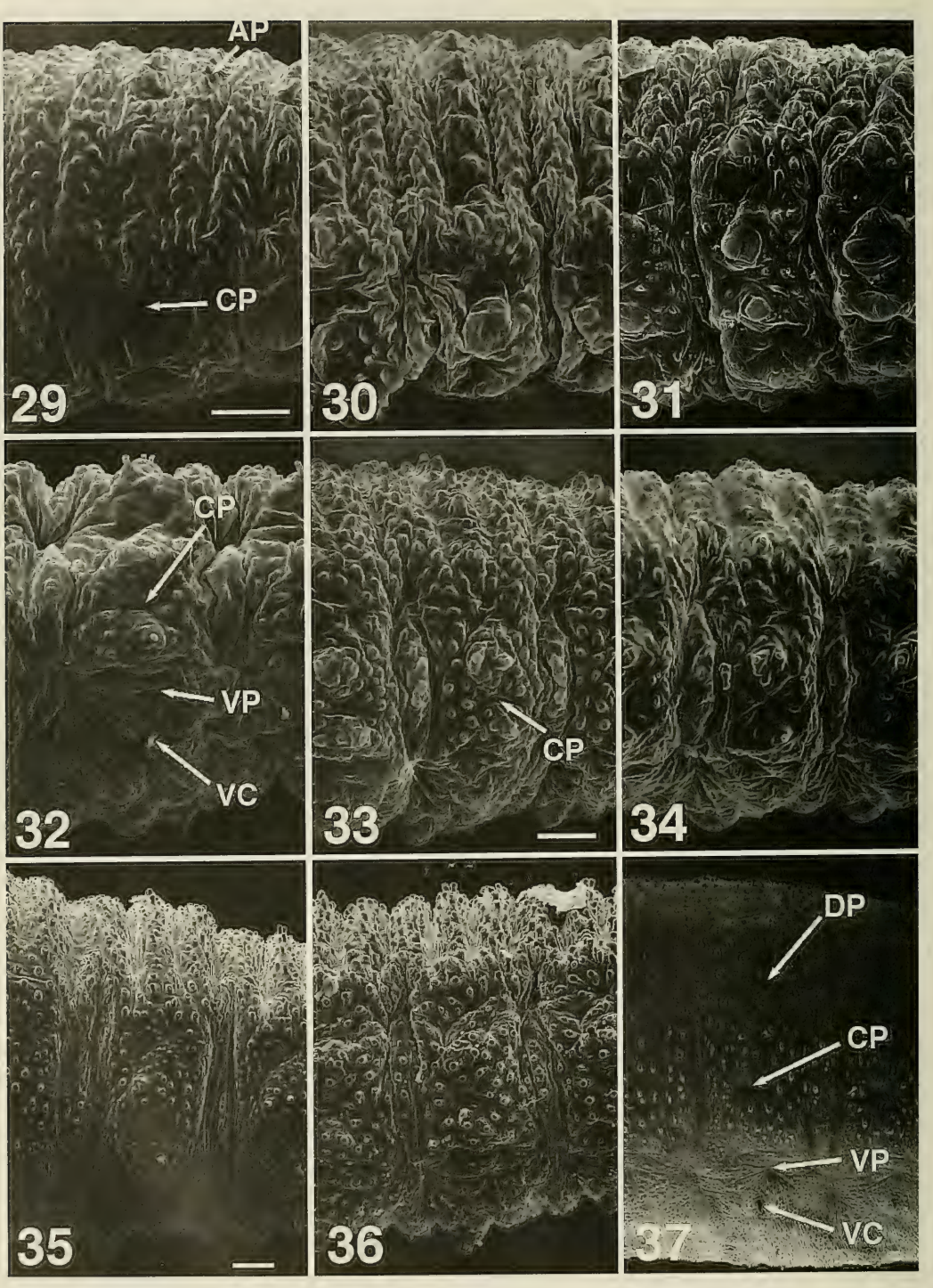
Figs. 24–28. Segment III, dorsal (anterior to right). 24, *Leucopis ninae,* third instar (scale bar = 0.1 mm). 25, *L. gaimarii* 'Central Ferry,' third instar. 26, *L. gaimarii* 'Anatone,' third instar. 27, *L. ninae,* puparium. 28, *L. gaimarii* 'Anatone,' puparium. Abbreviation: SP = shallow pits at lateral end of enlarged chaetoid row.

Dorsally (as in Fig. 12), similar to second instar, except middle pseudosegment (Fig. 24) with numerous, small, well-defined chaetoids and transverse row of 6 distinctly elongated, spinule-like chaetoids; single, additional spinule-like chaetoid isolated beyond lateral ends of row; segments 2 and 3 with longer chaetoids in row (see Fig. 57); middle pseudosegment not extended laterally beyond dorsal aspect, but appearing enclosed by deep groove; anterior and posterior pseudosegments with numerous, small, well-defined, separated chaetoids; chaetoid density 42–48, 46 chaetoids ($n > 10$).

Laterally (Figs. 15 and 57), similar to second instar, except lateral swelling with numerous, small, distinct, separated chaetoids (Fig. 35).

Ventrally, similar to second instar, except surface densely covered with tiny, well-defined chaetoids (Fig. 35); ventrolateral chaetoids forming distinct longitudinal row (Fig. 66).

Cephalic segment (Fig. 51) as in 2nd instar, except antennal papillae 2-segmented, basal segment disk-like, distal segment elongated; maxillary sensory papillae evident as pair of small disks separated by wide, vertical, median furrow; pair of larger papillae below these and lateral to preoral



Figs. 29–37. Segment III, lateral (anterior to right). 29, *Leucopis ninae,* first instar (scale bar = 0.05 mm). 30, *L. gaimarii* 'Central Ferry,' first instar. 31, *L. gaimarii* 'Anatone,' first instar. 32, *L. ninae,* second instar (note, specimen more rotated than in other figures). 33, *L. gaimarii* 'Central Ferry,' second instar (scale bar = 0.05 mm). 34, *L. gaimarii* 'Anatone,' second instar. 35, *L. ninae,* third instar (scale bar = 0.1 mm). 36, *L.*

cavity; cephalopharyngeal skeleton as in Fig. 45; gular region with incomplete, U-shaped collar or cephalic ring (as in Fig. 46).

Anterior spiracles as in second instar, only larger (Fig. 57); posterior spiracles trilobed, situated distally on long, tubular base (Fig. 55) which may be partially darkened and sclerotized near tip; bases separated by 0.20–0.45 mm (n > 10); covered with small chaetoids, similar to those of dorsal aspect; lobes as in second instar.

Segment VIII shallowly divided dorsally into 2 pseudosegments, each with small, scattered chaetoids (Fig. 66); posterior pseudosegment with about 30 well-defined, separated chaetoids between and continuing partially up on posterior spiracular processes; laterally, as in second instar, except caudal area with 2 elongated, spinule-like chaetoids above and between paired, projecting tubercles.

Leucopis gaimarii.—Length 2.10–4.20 [2.40–4.30] mm (n > 100); maximum width 0.55–1.20 mm.

Dorsally [Fig. 12], middle pseudosegment with scattered, poorly-defined [and contiguous] chaetoids subequal in size to transverse row of 6 enlarged, stubby chaetoids; additional indistinctly enlarged, stubby chaetoid isolated beyond lateral end of row; anterior and posterior pseudosegments with [numerous] poorly-defined, separated [contiguous (pattern appearing braided)] chaetoids, subequal in size to chaetoids of middle pseudosegment (Fig. 25 [26]); chaetoid density 16–23, 19 [22–26, 23] chaetoids (n > 10).

Laterally, segments 2 and 3 each with 3 enlarged, stubby chaetoids in triangular arrangement; segments I–VII each with lateral swelling bearing central pit and numerous, well-defined, separated chaetoids [Fig. 36]; swelling with 2 enlarged, stubby chaetoids dorsad and 1 ventrad to pit, also visible in dorsal aspect.

Ventrally, surface sparsely covered with tiny, scattered, poorly-defined chaetoids [Fig. 36]; middle pseudosegment with enlarged, stubby, ventrolateral chaetoid beneath ventrolateral pit, forming indistinct, longitudinal row.

Cephalopharyngeal skeleton as in Fig. 47 [46, 48].

Segment VIII, laterally with 3 enlarged, stubby chaetoids present in triangular arrangement; caudal area with few chaetoids, except for 2 enlarged, stubby chaetoids above and between paired, projecting tubercles.

Puparium

Leucopis ninae.—Length 2.45–2.90, 2.65 mm (n > 50); maximum width 0.87–1.15, 1.04 mm; upon pupariation integument off-white and slightly translucent, but within a short time hardens and darkens to reddish-brown, although puparial integument partially transparent so that parts of developing pupa are visible.

Dorsally (Fig. 16), subovate; posterior end bluntly rounded; anterior end abruptly tapered from segment I forward; segments distinct, but not deeply divided; segments 2–VII each divided into 3 pseudosegments with shallow, transverse depressions (Fig. 27); middle pseudosegment as in third instar; lateral end of transverse row of 6 distinctly elongated, spinule-like chaetoids with 2 shallow pits (Figs. 17 and 27); segments 2–I with elongated, spinule-like chaetoids in transverse row; anterior and posterior pseudosegments as in third instar; chaetoid density 42–48, 45 chaetoids (n > 10).

Laterally (as in Fig. 17), highly convex above and distinctly flattened below; anteriorly, segments I–1 become conspicuously

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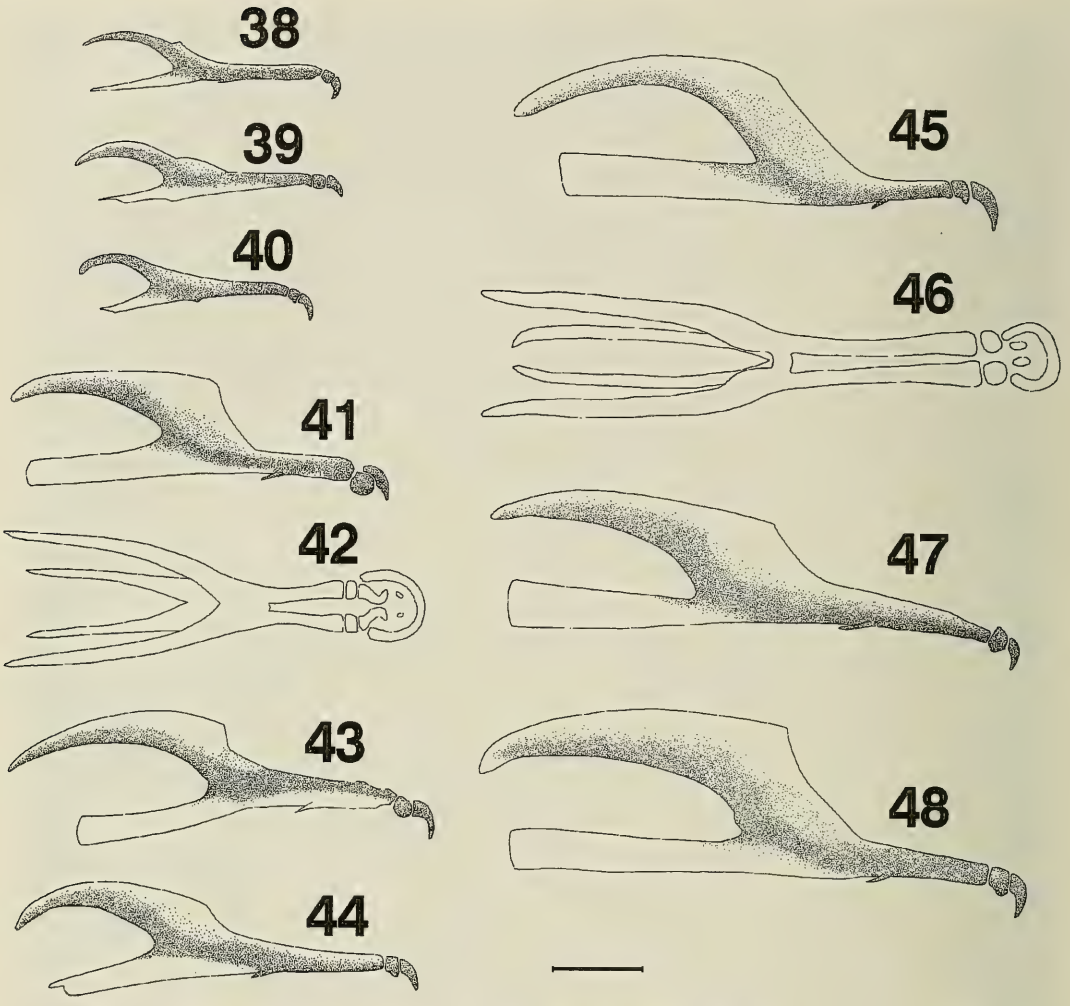
gaimarii 'Anatone,' third instar. 37, *L. ninae,* puparium. Abbreviations: AP = anterior pseudosegment; CP = central pit of swelling; DP = dorsolateral pit; VC = ventrolateral chaetoid; VP = ventrolateral pit.

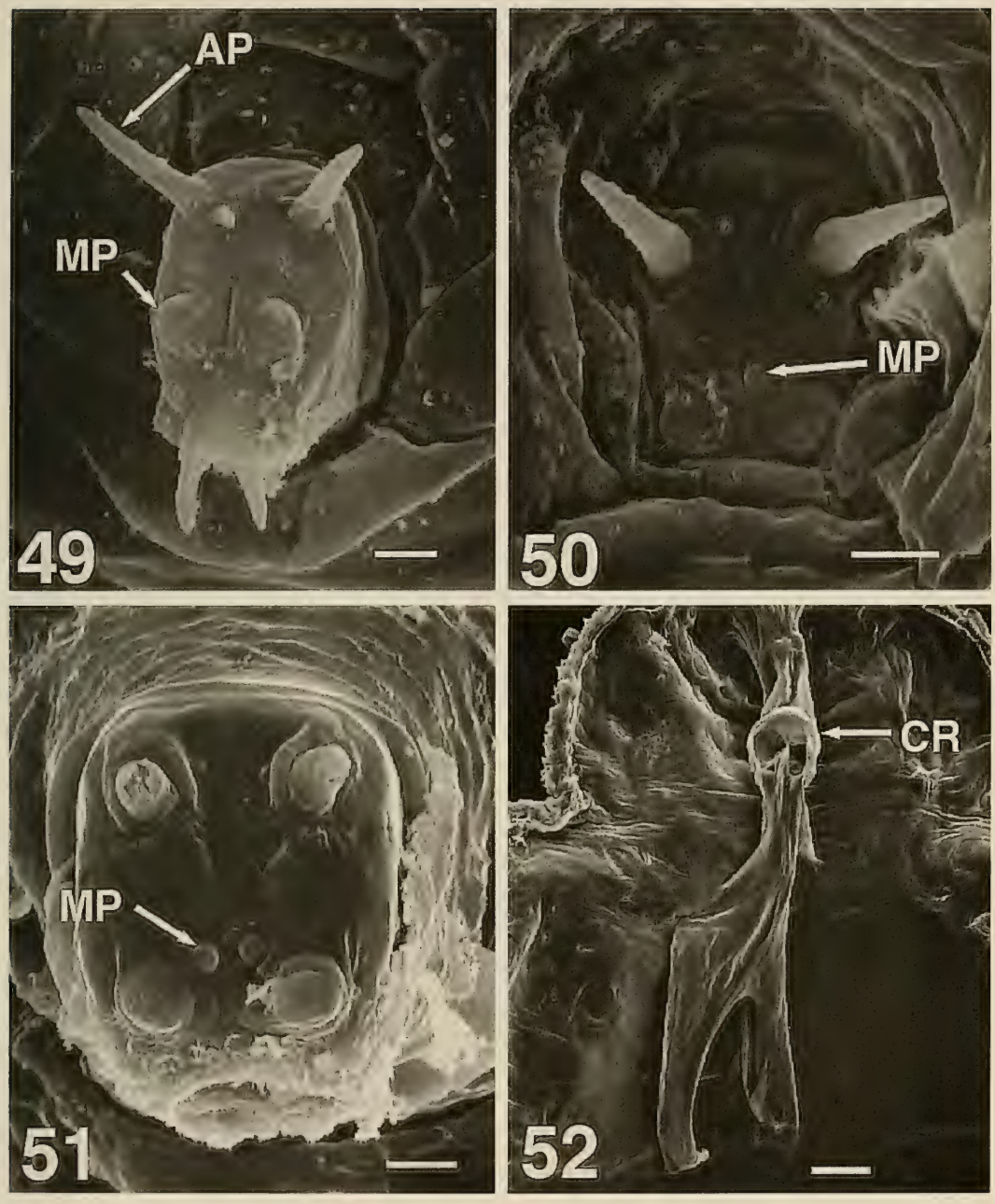


Figs. 38–48. Cephalopharyngeal skeleton. 38, *Leucopis ninae,* first instar. 39, *L. gaimarii* 'Central Ferry,' first instar. 40, *L. gaimarii* 'Anatone,' first instar. 41, *L. ninae,* second instar. 42, *L. ninae,* dorsal second instar. 43, *L. gaimarii* 'Central Ferry,' second instar. 44, *L. gaimarii* 'Anatone,' second instar. 45, *L. ninae,* third instar. 46, *L. gaimarii* 'Anatone,' dorsal third instar. 47, *L. gaimarii* 'Central Ferry,' third instar. 48, *L. gaimarii* 'Anatone,' third instar. Scale bar = 0.05 mm.

flattened dorsoventrally; pseudosegmentation not apparent; segments I–VII each with indistinct, lateral swelling (Fig. 37); swelling sparsely covered with small, well-defined chaetoids, and 3 elongated, spinule-like chaetoids in triangular arrangement around central pit: 2 above and 1 below; elongated chaetoids prominent in dorsal aspect; dorsolateral pit above central pit of swelling and lateral to paired depressions at end of transverse row of chaetoids on middle pseudosegment of dorsal aspect.

Ventrally (Fig. 37), 3 pseudosegments apparent, divided by shallow, transverse depressions; creeping welts absent due to inflation of integument; pseudosegments densely covered with tiny, separated chaetoids; middle pseudosegment with elongated, spinule-like, ventrolateral chaetoid beneath ventrolateral pit.

Head region appearing wrinkled (Fig. 59); cephalic segment retracted into segment 1 and not visible; segments 2 and 3 surrounded by elongated, spinule-like chae-



Figs. 49–52. Cephalic structures. 49, *Leucopis gaimarii* 'Anatone,' first instar, cephalic segment (scale bar = 0.005 mm). 50, *L. ninae,* second instar, cephalic segment (scale bar = 0.01 mm). 51, *L. ninae,* third instar, cephalic segment (scale bar = 0.01 mm) (note: AP appears broken off). 52, *L. ninae,* cephalopharyngeal skeleton from emerged puparium (scale bar = 0.05 mm). Abbreviations: AP = antennal papilla; CR = cephalic ring; MP = maxillary sensory papilla.

toids; cephalopharyngeal skeleton of third instar visible on inside ventral portion of anterior segments after adult emergence; incomplete collar, or cephalic ring, visible (Fig. 52).

Anterior spiracles either 3-lobed (as in Figs. 58 and 59), 4-lobed (as in Fig. 61), or mixed (as in Fig. 60), as in second and third instar, except protracted farther and more conspicuous; posterior spiracles (Fig. 67) as in third instar, but fully sclerotized; bases separated by 0.18–0.35, 0.27 mm (n > 50).

Segment VIII shallowly divided dorsally into 2 pseudosegments, each with small, scattered chaetoids (Fig. 67); posterior pseudosegment with about 30 small, well-defined, separated chaetoids between and continuing partially up on posterior spiracular processes; laterally, 3 elongated, spinule-like chaetoids present in triangular arrangement; caudal area with few chaetoids, except 2 slightly enlarged chaetoids between and above paired, projecting tubercles; anus situated below; hardened droplet of black, shiny exudate from anus usually present (not shown in Figures), resulting from gut contents purged prior to pupariation.

Leucopis gaimarii.—Length 2.30–2.75, 2.56 [2.35–2.90, 2.62] mm (n > 50); maximum width 0.80–1.20, 1.03 [0.90–1.20, 1.05] mm.

Dorsally, middle pseudosegment with numerous, poorly-defined, contiguous and flattened chaetoids subequal in size to transverse row of 6 indistinctly enlarged chaetoids [Fig. 28]; additional enlarged chaetoid isolated beyond lateral end of row; anterior and posterior pseudosegments with poorly-defined, contiguous and flattened chaetoids; chaetoid density 16–23, 21 [22–26, 24] chaetoids (n > 10).

Laterally (Fig. 17), lateral swelling densely [sparsely] covered with small, well-defined chaetoids, and 3 slightly enlarged, blunt chaetoids in triangular arrangement around central pit: 2 above and 1 below; enlarged chaetoids visible in dorsal aspect, but short and stubby.

Ventrally, middle pseudosegment with indistinctly enlarged, blunt, ventrolateral chaetoid beneath ventrolateral pit.

Posterior spiracles with bases separated by 0.28–0.38, 0.31 [0.29–0.44, 0.35] mm (n > 50).

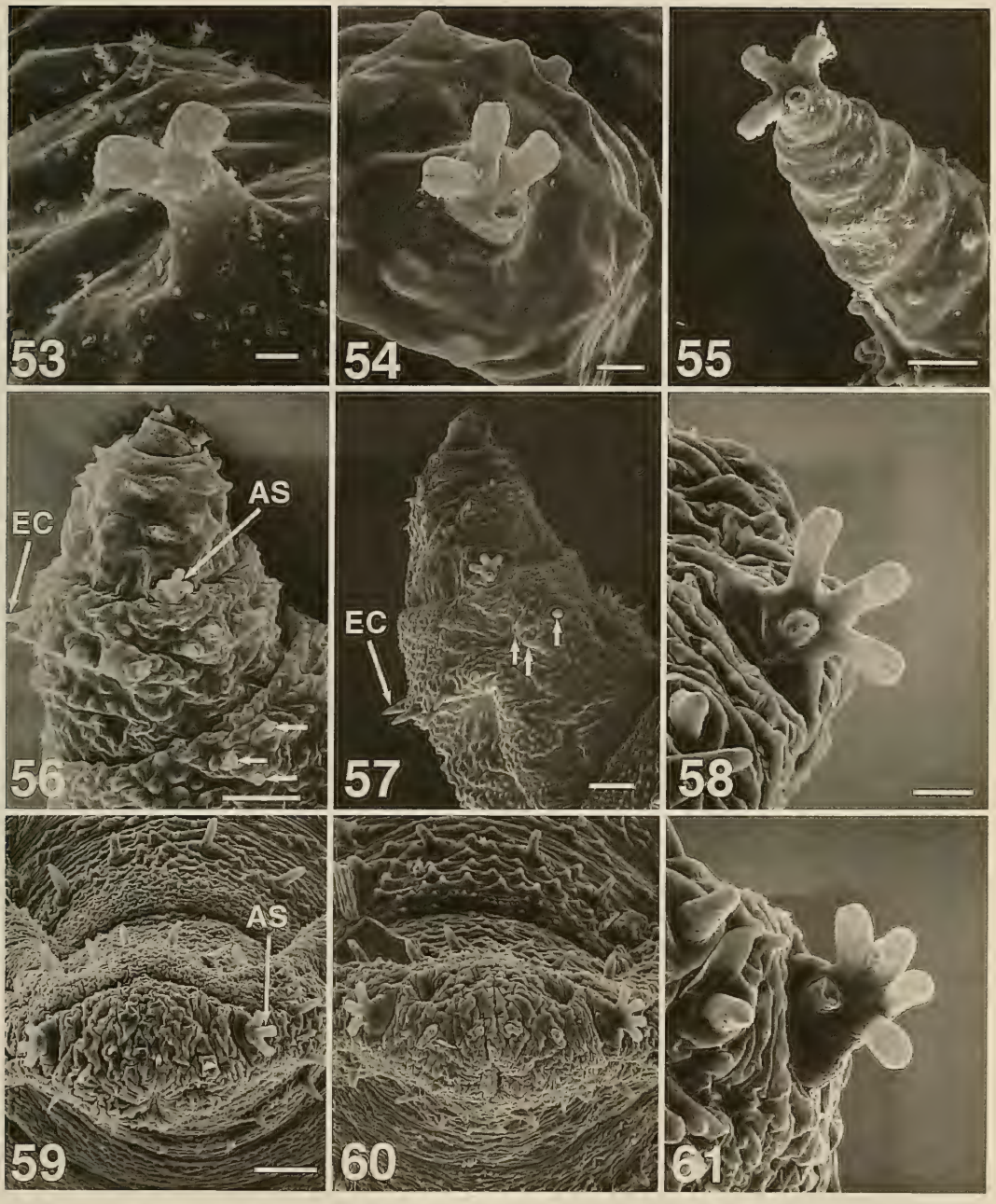
Segment VIII, laterally with 3 enlarged, stubby chaetoids present in triangular arrangement.

Discussion

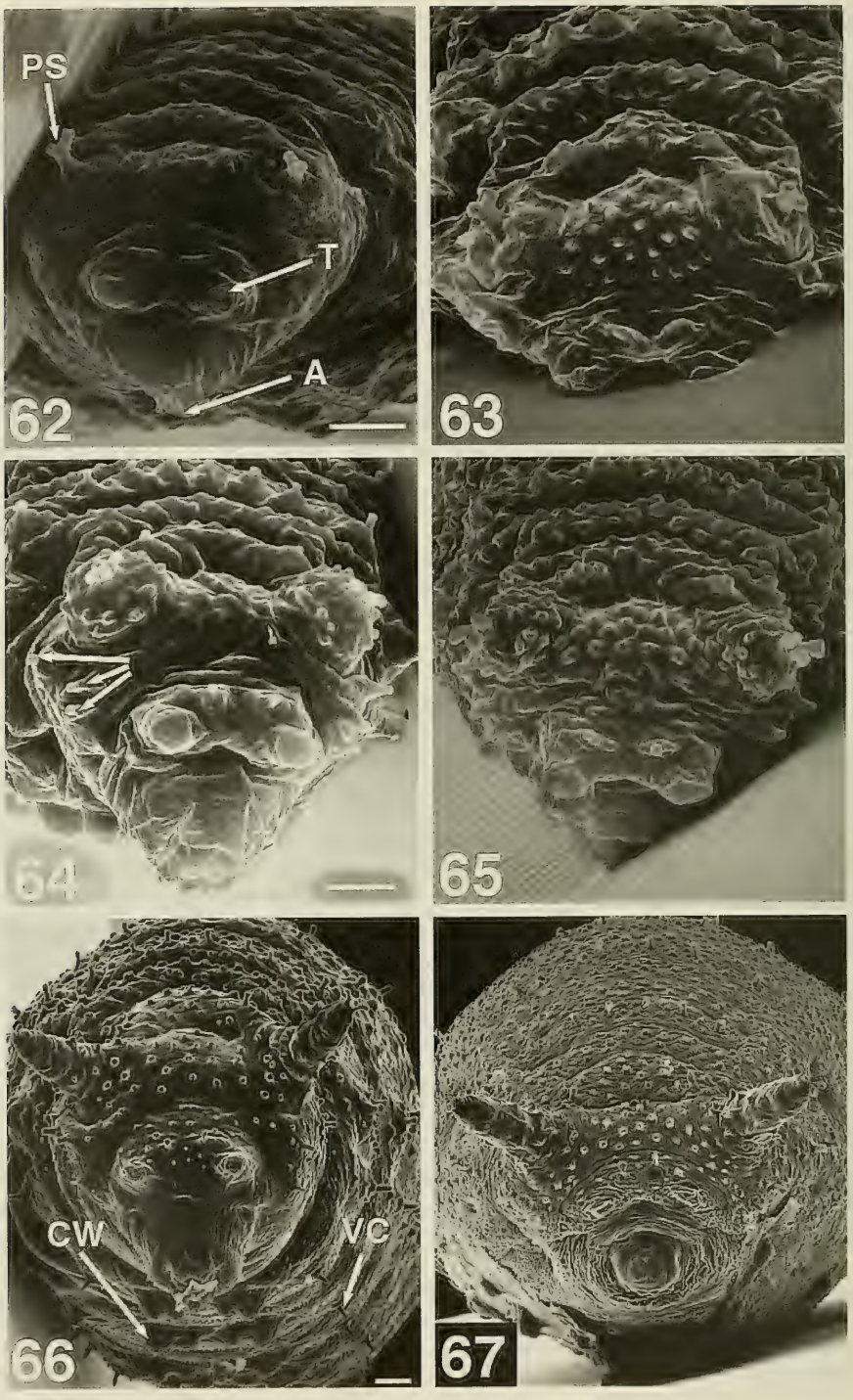
In most cases, differences between the populations were not profound, but at least subtle differences were discovered in all stages and instars. Character differences in the egg stage involve chorionic reticulation patterns and the anastamosing of longitudinal ridges. Those of the larval and puparial stages involved surface sculpturing, and the nature and definition of chaetoids.

The egg of *Leucopis gaimarii* 'Central Ferry' is most distinctly different from that of the other two populations in the chorionic latticework, where the pore density is highest and the average pore diameter is smallest. Eggs of both *L. ninae* and *L. gaimarii* 'Anatone' have similar chorionic pore densities; however, in *L. ninae,* the ratio of pore diameter to inter-pore distance is typically less than 1:1, and all pores appear smoothed and rounded. In *L. gaimarii* 'Anatone', the ratio of pore diameter to inter-pore distance is greater than 1:1, and all pores usually display an angular appearance. Eggs of *L. gaimarii* 'Central Ferry' are also unique in that the dorsal longitudinal ridges are closely parallel and unbranched within the transverse dorsomedian area. In the other two, ridges appear subparallel, with at least occasional anastamosing within the dorsomedian area.

Differences among first larval instars of the three species are associated largely with the nature and pattern of small chaetoids on the dorsal aspect of the anterior and posterior pseudosegments of segments 2–VII. In both populations of *L. gaimarii,* the chaetoids are contiguous and arranged in a braided pattern, while those of *L. ninae* are



Figs. 53–61. Spiracles. 53, *Leucopis gaimarii* 'Anatone,' first instar, posterior spiracular process (scale bar = 0.005 mm). 54, *L. ninae,* second instar, posterior spiracular process (scale bar = 0.01 mm). 55, *L. ninae,* third instar, posterior spiracular process (scale bar = 0.05 mm). 56, *L. gaimarii* 'Central Ferry,' second instar, segments 1–3, lateral (scale bar = 0.05 mm). 57, *L. ninae,* third instar, segments 1–2, lateral (scale bar = 0.05 mm). 58, *L gaimarii* 'Anatone,' puparium, anterior spiracular process (scale bar = 0.02 mm). 59, *L. ninae,* puparium, frontal (scale bar = 0.05 mm). 60, *L. gaimarii* 'Central Ferry,' puparium, frontal. 61, *L. gaimarii,* 'Central Ferry,' anterior spiracular process. Abbreviations: AS = anterior spiracular process; EC = elongated chaetoid; unlabelled arrows = triangular arrangement of enlarged chaetoids.



Figs. 62–67. Segment VIII, posterior. 62, *Leucopis ninae,* first instar (scale bar = 0.05 mm). 63, *L. gaimarii* 'Central Ferry,' first instar. 64, *L. ninae,* second instar (scale bar = 0.05 mm). 65, *L. gaimarii* 'Central Ferry,' second instar. 66, *L. ninae,* third instar (scale bar = 0.1 mm). 67, *L. ninae,* puparium. Abbreviations: A = anus; CW = creeping welt; PS = posterior spiracle; T = tubercle; VC = ventrolateral chaetoid; unlabelled arrows = triangular arrangement of enlarged chaetoids.

separated. In addition, the chaetoid density is higher in *L. gaimarii* 'Central Ferry' than in *L. gaimarii* 'Anatone'. The chaetoid density of *L. ninae* is intermediate to those for the two populations of *L. gaimarii.*

The second instar of *L. ninae* is very distinctive. Elongated, spinule-like chaetoids are present in the transverse row of the middle pseudosegments and on the lateral swellings of this species. Both populations of *L. gaimarii* have enlarged, stubby chaetoids in the transverse row and on the swellings. These chaetoids are more well-defined in the 'Central Ferry' population than in the 'Anatone' population. Also, in *L. ninae,* the chaetoids on the anterior and posterior pseudosegments are poorly-defined and separated. By comparison, these chaetoids are contiguous in both populations of *L. gaimarii,* but are poorly-defined only in the 'Anatone' population. The lateral swelling of *L. gaimarii* 'Central Ferry' is also distinctive from that present in the other two, with a dense covering of small, well-defined chaetoids. The other two populations appear quite similar to one another in this character, with only sparse, small, poorly-defined chaetoids. In addition, for *L. ninae,* the small chaetoids of the posterior pseudosegment of segment VIII are distinctive. The chaetoids are poorly-defined, separated, and sparse (≈14) between the posterior spiracular processes. Both populations of *L. gaimarii* have more than 20 well-defined, contiguous or crowded chaetoids between the spiracles.

The most distinctive differences among larvae were found in the third instar. In only *L. ninae* is the transverse row of enlarged chaetoids still clearly visible. As in the second instar, these chaetoids are elongated, spinule-like, and distinctly larger than the other chaetoids present. In both *L. gaimarii* populations, the dorsal chaetoids of all three pseudosegments are stubby and subequal in size. Also, in *L. ninae,* the small chaetoids on the dorsum of the anterior and posterior pseudosegments are well-defined, separated, and dense, numbering over twice that in either *L. gaimarii* population. The chaetoids of *L. gaimarii* are poorly-defined, with those of the 'Anatone' population appearing contiguous in a braided pattern. In *L. ninae* the lateral swellings have 3 elongated, spinule-like chaetoids in a triangular arrangement. By comparison, the chaetoids are short and stubby in both *L. gaimarii* populations. In lateral view, part of the ventral surface is visible. This surface of *L. ninae* is densely covered with tiny, well-defined chaetoids, while that of either population of *L. gaimarii* is sparsely studded with tiny, poorly-defined chaetoids. In addition, the ventrolateral chaetoid is elongated and spinule-like only in *L. ninae.*

The characters of the puparial stage are essentially the same as for the third larval instar, with only minor differences. For example, the small, separated chaetoids of the third larval instar of *L. gaimarii* 'Central Ferry' appear both contiguous and braided in the puparium. Additionally, the small chaetoids of both populations of *L. gaimarii* appear more flattened or decumbent.

This study serves to illustrate the inter- and possibly intra-specific variability of *Leucopis* (*s. str.*) in the immature stages. Although the adults of the two populations of *L. gaimarii* could not be differentiated (Tanasijtshuk 1996b), the immatures, which were reared simultaneously under identical conditions, were distinguishable. Likewise, biological differences were apparent (Gaimari and Turner 1996). These consistent differences in immatures suggest that there is likely some real difference between the populations. Because *Diuraphis noxia* is a recently introduced cereal aphid in the Pacific Northwest, we can assume that it is not a native host for either population of *L. gaimarii.* In fact, specimens now identifiable as *L. gaimarii* had been collected in the region as early as 1912, with some from aphids on *Elymus* (Poaceae) (Tanasijtshuk 1996b), well before the introduction of the *D. noxia.* A possible explanation for the differences in the immature stages is that the two populations were recently separated,

perhaps by host or elevational preferences, and had begun to diverge when *D. noxia* entered the region and provided a suitable, unexploited resource for both of them. The characters of the immature stages could have diverged before those of the adults due to the different evolutionary pressures on functional morphology applied while feeding in different host homopteran colonies. Alternatively, *L. gaimarii* may have some degree of populational plasticity in the immature stages, due to any number of possible factors, including those mentioned above. According to Tanasijtshuk (1996b), the adults were also quite variable in certain characteristics, but not as divided into distinct populations. Nevertheless, the possibility that the populations are somehow distinct warrants further exploration, perhaps using allozyme comparisons to look for fixed gene loci, or simple cross-breeding experiments.

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LARVAL FEEDING AND DEVELOPMENT OF *LEUCOPIS NINAE* TANASIJTSHUK AND TWO POPULATIONS OF *LEUCOPIS GAIMARII* TANASIJTSHUK (DIPTERA: CHAMAEMYIIDAE) ON RUSSIAN WHEAT APHID, *DIURAPHIS NOXIA* (MORDVILKO) (HOMOPTERA: APHIDIDAE), IN WASHINGTON

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Abstract.—Three populations of *Leucopis* (Diptera: Chamaemyiidae), including *L. ninae* Tanasijtshuk and two populations of *L. gaimarii* Tanasijtshuk, were studied to determine their relative larval development times and feeding rates at different temperatures. Using three experimental temperatures (20.0°, 23.3°, 26.6°C), we determined that the developmental times of all three populations significantly decreased with increasing temperature. Additionally, the number of aphids consumed per day significantly increased from the lowest to the highest experimental temperatures for each population. There were few differences among the three populations for the aspects studied, although one population of *L. gaimarii* had a significantly ($P > 0.005$) longer third stadium (and total larval duration) at the lowest experimental temperature than either *L. ninae* or the other population of *L. gaimarii.* This coincided with a higher mean number of aphids consumed for this population at this temperature. Most importantly, we found that these *Leucopis* species are voracious predators on aphids, with each individual killing approximately 100 aphids throughout larval life. Also, our data suggests that the species native to the Pacific Northwest, *L. gaimarii,* is as effective a predator on the Russian wheat aphid as the introduced species, *L. ninae.*

Key Words: Chamaemyiidae, *Leucopis,* larval feeding, larval development, Aphididae, *Diuraphis noxia,* Russian wheat aphid, biocontrol

All larval Chamaemyiidae that have been studied are predators on soft-bodied homopterans, particularly those in the superfamilies Aphidoidea and Coccoidea. Because this group of flies is potentially useful in biological control programs targeting aphids, adelgids, scales, and mealybugs (Balch 1952, Balch et al. 1956, Brown and Clark 1957, Clark and Brown 1962, Culliney et al. 1988, Delucchi and Pschorn-Walcher 1954, Eichhorn 1968, Gaimari 1991, Greathead 1995, Mills 1990, Nakao et al. 1981, Stevenson 1967, Tanasijtshuk 1986, Tiensuu 1951, Tracewski 1983, Wilson 1938), there is a need for more information on larval feeding and development.

Besides a general understanding of the Chamaemyiidae as predators of soft-bodied homopterans, the feeding habits are poorly understood. Some, but not all, genera have been associated with particular groups of homopterans, e.g. *Chamaemyia* Meigen and *Parochthiphila* Czerny on mealybugs of grasses and *Neoleucopis* Malloch on Adel-

gidae. However, most species within the family have never actually been associated with particular hosts, and very few biological observations have been recorded. Specific larval feeding habits have been recorded for very few of the known Nearctic species of the genus *Leucopis* Meigen (Bennett 1961, Gaimari 1993, Maple 1934, McAlpine and Tanasijtshuk 1972, Sluss and Foote 1971, 1973, Tracewski 1983). Tanasijtshuk (1986) summarizes much of the known information for Palearctic species of this and other genera, including host ranges. Additional biological information is available for certain species of *Chamaemyia* (Raspi 1983, Tanasijtshuk 1970b), *Leucopis* (including all the subgenera) (Cherian 1933, Cottam 1922, McAlpine 1977, 1978, Raspi 1983, Sandhu and Kaushal 1975, Tanasijtshuk 1959, 1961, 1962, 1970a, 1972, Tawfik 1965, Valenti and Gaimari 1992), *Leucopomyia* Malloch (Babaev and Tanasijtshuk 1971, Tanasijtshuk 1965), *Lipoleucopis* de Meijere (Wilson 1938), *Melaleucopis* Sabrosky (Beingolea 1957), *Neoleucopis* (Brown and Clark 1957, Clark and Brown 1957, McAlpine 1971), *Parochthiphila* (Raspi 1983, Tanasijtshuk 1963, 1968), and *Pseudodinia* Coquillett (Barber 1984, 1985).

This paper provides information on two species of *Leucopis* (*s. str.*), namely *L. ninae* Tanasijtshuk from Skopje, Macedonia (approximately 42°N 21°E) and two populations of *L. gaimarii* Tanasijtshuk from eastern Washington (Gaimari 1993, Gaimari and Turner 1996, Tanasijtshuk 1996). We compared their developmental times at three temperatures for all larval instars and the puparial stage. We also compared their larval feeding rates on *D. noxia,* and their total aphid consumption in controlled conditions. At the time of this study, *L. ninae* was first being released against *D. noxia* in the Pacific Northwest by USDA-APHIS-PPQ (Prokrym et al., in press). The life history information and observations presented herein points to the usefulness of pre-release comparisons of the biology of exotic predators slated for release with their native congeners.

Materials and Methods

The *Leucopis* species were maintained in the Northwest Biological Control Insectary and Quarantine at Washington State University, and *D. noxia* were from a USDA-ARS colony. The 'Central Ferry' population of *L. gaimarii* (*L.* sp. #1 of Gaimari [1993]) originated in Washington, Garfield County, Central Ferry, USDA-ARS Research Farm (46°37′N 117°49′W; elevation 195 m), swept from cereal ryegrass, *Secale cereale* Linnaeus (Poaceae), infested with the Russian wheat aphid, *Diuraphis noxia* (Mordvilko) (Homoptera: Aphididae), in July 1991. The 'Anatone' population of *L. gaimarii* (*L.* sp. #2 of Gaimari [1993]) originated in Washington, Asotin County, 0.6 km west Anatone (46°08′N 117°08′W; elevation 1160 m), swept from *D. noxia*-infested wheat, *Triticum aestivum* Linnaeus (Poaceae), in August 1991. Additional information on the origins and maintenance of the fly and aphid colonies can be found in Gaimari (1993), but note that all three populations were originally collected in the field from *D. noxia*-infested cereal grasses.

The experimental aphid host-plant was 'Steptoe' barley, *Hordeum vulgare* Linnaeus (Poaceae), chosen for its broader leaf compared with wheat. For a continual supply of plants, we sowed 30 seeds into each of two 13 cm pots every five days, and grew them at 25 ± 5°C under constant light to a height of 15 cm, with the first leaf unfolded (Stage 1 of Feekes Scale [Large 1954]). Plants were then maintained in an experimental growth chamber (23.3 ± 3.4°C; photoperiod of 16:8 h).

We performed experiments at three temperatures (20.0 ± 0.1°, 23.3 ± 0.1°, and 26.6 ± 0.1°C) using illuminated incubators with the same photoperiod as above. At each temperature, there were 15 replicates for *L. ninae* and for each population of *L. gaimarii.* Each replicate required a study apparatus (modified from Barber 1984)

consisting of clear, glass tubing, 15–16 cm in length, with an inner diameter of 0.55 cm and an outer diameter of 0.7 cm. Stiff paper (biological drawing stock) was cut into 13 × 0.65 cm strips, and a single, green, healthy barley leaf was clipped and anchored with nontoxic white glue along its entire length to each paper strip, to prevent aphids from getting under the leaf. The glue was allowed to air dry for 20 minutes, after which the paper strips were curled to permit insertion into the glass tube. Each barley leaf was replaced with a fresh one every two days. Plants of uniform age (10–15 days old) were used throughout the study.

We transferred a single *Leucopis* egg (from a *D. noxia*-reared culture) and 10 *D. noxia* nymphs (third instar or older) to the top surface of each barley leaf, using a 00 camel's-hair brush. Eggs were collected from throughout the rearing cages and from different females. Each leaf was slipped into a glass tube and both ends were plugged with cotton. Each tube was affixed to a number-coded, wooden mount. All apparati were placed on a single shelf in the appropriate incubator.

After egg hatch, we counted and removed all live aphids and carcasses daily to determine the number of aphids killed and consumed by each larva. Shriveled carcasses were considered to have been the result of predation, while the uncommonly encountered entire carcasses were not, as they may have died from other causes. We then added fresh aphid nymphs from the *D. noxia* colony to bring the number in each apparatus to the required quantity as described below.

The number of aphid nymphs provided to the maggots was based on preliminary studies and varied as follows. Throughout the first stadium, 10 aphids were used. The number was increased to 20 for the second stadium (at the highest experimental temperature, the number of aphids supplied here was increased to 30, due to an increased rate of predation). For the third stadium, the number of aphids added each day was increased to 30 (again, at the highest experimental temperature, an additional 10 were provided).

After pupariation, we carefully removed each puparium from the tube by breaking the sticky adhesive that attached them to the substrate (Gaimari 1993). We then moved each into a labeled, plastic, tissue-culture dish and placed them back into the incubator to await adult emergence.

Following adult emergence and tanning, the tissue-culture dishes were dated and stored at −0.5°C. Each adult specimen and its associated puparium was point-mounted on the same insect pin, and placed in the Maurice T. James Entomological Collection at Washington State University.

Statistical analyses were made using a one-factor analysis of variance with repeated measures, comparing: the number of aphid nymphs consumed by each population within a given experimental temperature; the number of aphid nymphs consumed at each temperature within a population; the developmental period between populations within a given experimental temperature; and the developmental period at each temperature within a population. We used Scheffé's F-test to detect differences significant at 95% between populations. For all calculated F-values, df = 2, 28 and, unless stated otherwise, $P < 0.001$.

Results

Developmental time.—Temperature influenced the time spent in each larval instar and puparial stage of the three *Leucopis* populations. In each, the time for completion of each stadium or life stage, in addition to the total time, decreased with increasing temperature (Table 1). This trend is illustrated by the total time required to complete development from egg to adult in each population as temperature increased from 20.0 to 26.6°C (Fig. 1). Within each population, the resulting F-values of the statistical analyses of mean developmental times at the different temperatures are given in Table 2.

Table 1. Mean developmental times ± SE (days) for three *Leucopis* populations. In each row, mean values followed by different lower case letters are different (df = 2, 28; $P < 0.001$; Scheffé's F-test), while in each column (within a stage or instar), mean values followed by different upper case letters are different (see Table 2; Scheffé's F-test). The same letter or absence of lettering denotes no significant difference.

		L. ninae	*L. gaimarii* 'Central Ferry'	*L. gaimarii* 'Anatone'
1st instar:	20.0°C	2.50 ± 0.07 A	2.50 ± 0.07 A	2.57 ± 0.08 A
	23.3°C	2.10 ± 0.10 B	2.07 ± 0.12 B	2.23 ± 0.11 A
	26.6°C	1.70 ± 0.10 C	1.93 ± 0.10 B	1.77 ± 0.10 B
2nd instar:	20.0°C	2.47 ± 0.08 A	2.37 ± 0.08 A	2.37 ± 0.10 A
	23.3°C	2.30 ± 0.14 A	1.97 ± 0.10 B	2.07 ± 0.12 A
	26.6°C	1.20 ± 0.08 B	1.37 ± 0.06 C	1.27 ± 0.10 B
3rd instar:	20.0°C	4.53 ± 0.12 aA	4.60 ± 0.11 aA	5.80 ± 0.18 bA
	23.3°C	3.73 ± 0.19 B	3.87 ± 0.15 B	4.07 ± 0.12 B
	26.6°C	3.20 ± 0.14 B	3.27 ± 0.10 C	3.23 ± 0.14 C
larval total:	20.0°C	9.47 ± 0.19 aA	9.47 ± 0.17 aA	10.73 ± 0.26 b[1]A
	23.3°C	8.10 ± 0.25 B	7.90 ± 0.16 B	8.37 ± 0.23 B
	26.6°C	6.07 ± 0.19 C	6.67 ± 0.16 C	6.27 ± 0.16 C
puparial:	20.0°C	13.20 ± 0.15 A	12.67 ± 0.16 A	12.93 ± 0.21 A
	23.3°	9.93 ± 0.15 B	10.13 ± 0.13 B	10.40 ± 0.13 B
	26.6°C	8.13 ± 0.13 C	7.93 ± 0.15 C	7.93 ± 0.07 C
total:	20.0°C	23.13 ± 0.19 a[2]A	22.40 ± 0.24 aA	24.07 ± 0.28 bA
	23.3°C	18.27 ± 0.27 B	18.20 ± 0.22 B	19.07 ± 0.35 B
	26.6°C	14.27 ± 0.15 C	14.73 ± 0.27 C	14.27 ± 0.12 C

[1] Different at $P < 0.005$; [2] Different at $P < 0.05$.

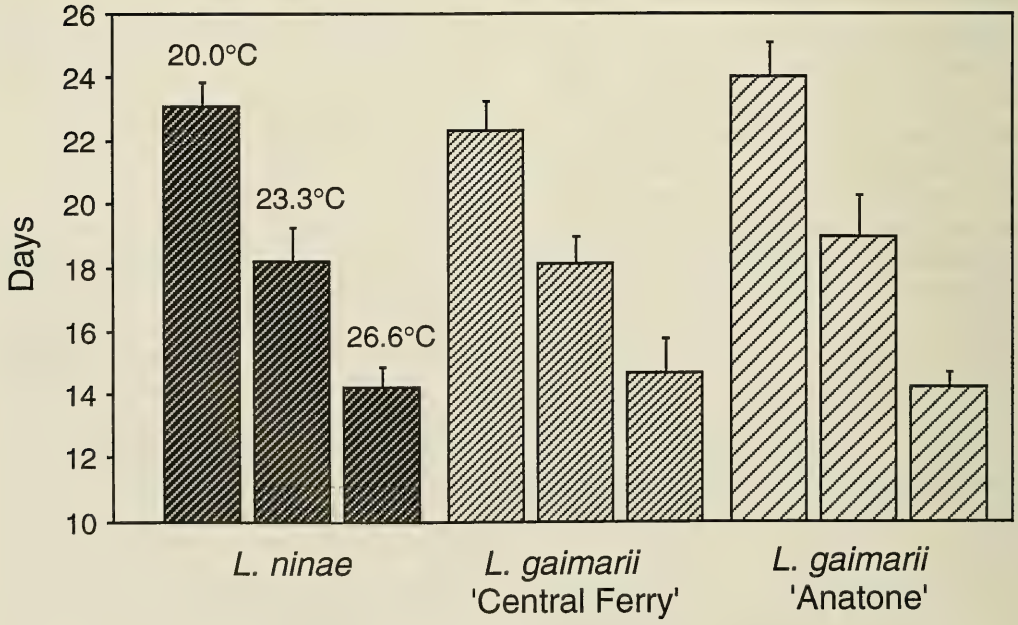

Fig. 1. Total developmental times from egg to adult for *Leucopis ninae* and two populations of *L. gaimarii* at three experimental temperatures. Error bars = SE.

Table 2. *F*-values for the differences in number of *D. noxia* nymphs consumed by each larval instar of three *Leucopis* populations at the three experimental temperatures (df = 2, 28; $P < 0.001$; Scheffé's *F*-test).

		L. ninae	*L. gaimarii* 'Central Ferry'	*L. gaimarii* 'Anatone'
1st instar:	20.0 vs. 23.3°C	4.54[2]	4.05[2]	—
	23.3 vs. 26.6°C	4.54[2]	—	5.50[3]
	20.0 vs. 26.6°C	18.16	6.93[1]	16.17
2nd instar:	20.0 vs. 23.3°C	—	5.48[3]	—
	23.3 vs. 26.6°C	48.45	12.33	14.50
	20.0 vs. 26.6°C	64.25	34.24	27.42
3rd instar:	20.0 vs. 23.3°C	7.21[1]	9.75	29.86
	23.3 vs. 26.6°C	—	6.53[1]	6.90[1]
	20.0 vs. 26.6°C	20.02	32.25	65.46
larval total:	20.0 vs. 23.3°C	14.68	23.60	27.54
	23.3 vs. 26.6°C	32.51	14.62	21.68
	20.0 vs. 26.6°C	90.88	75.37	98.10
puparia:	20.0 vs. 23;3°C	127.97	80.65	64.25
	23.3 vs. 26.6°C	38.86	60.82	60.91
	20.0 vs. 26.6°C	307.86	281.55	250.27
total:	20.0 vs. 23.3°C	189.04	84.88	75.14
	23.3 vs. 26.6°C	127.70	57.83	69.25
	20.0 vs. 26.6°C	627.48	282.82	288.67

[1] Different at $P < 0.005$; [2] Different at $P < 0.05$; [3] Different at $P < 0.01$.

There were no differences in developmental times among the three species at the highest two temperatures, 23.3°C and 26.6°C (see Table 1). At 20.0°C, however, the duration of the third stadium of *L. gaimarii* 'Anatone' was longer than that for either *L. ninae* ($F = 20.83$) or *L. gaimarii* 'Central Ferry' ($F = 18.69$). Subsequently, the entire larval stage of *L. gaimarii* 'Anatone' was longer than that for either of the other two ($F = 8.51$; $P < 0.005$), and the total time from egg to adult was longer for *L. gaimarii* 'Anatone' than for either *L. ninae* ($F = 3.75$; $P < 0.05$) or *L. gaimarii* 'Central Ferry' ($F = 11.95$).

Feeding.—The larval feeding rates (aphids consumed per day) increased as temperature increased from 20.0° to 26.6°C for each species (Fig. 2): *L. ninae* ($F = 60.52$), *L. gaimarii* 'Central Ferry' ($F = 29.03$), and *L. gaimarii* 'Anatone' ($F = 79.33$). However, for each species, the mean number of aphid nymphs consumed (Table 3) by first and second instars and overall did not change with increasing temperature. In the third stadium, by contrast, there was

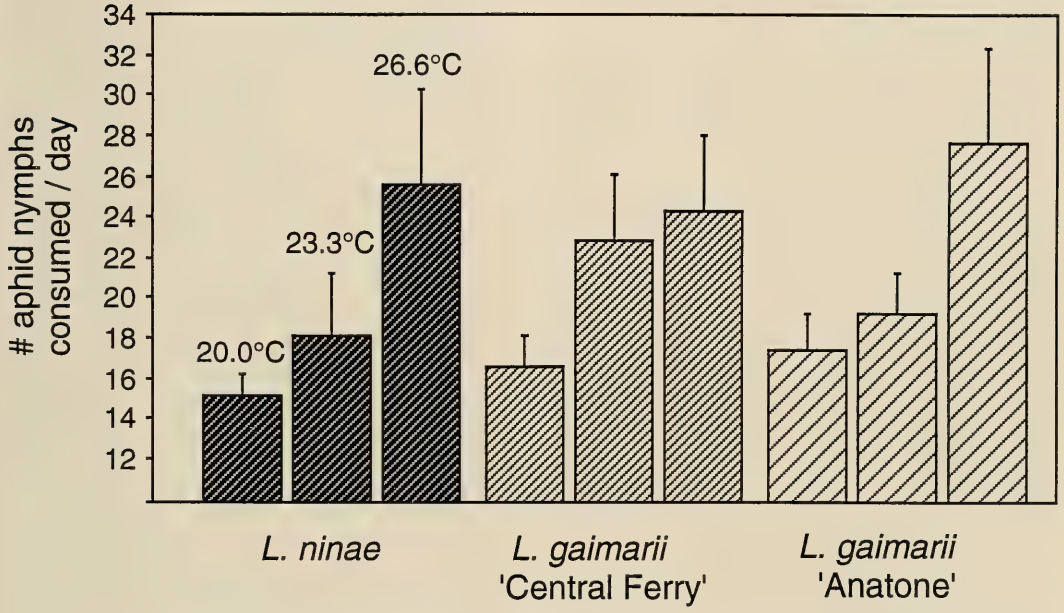

Fig. 2. Mean consumption rates of *Diuraphis noxia* for larval *Leucopis ninae* and two populations of *L. gaimarii* at three experimental temperatures. Error bars = SE.

Table 3. Mean number of *D. noxia* nymphs consumed ± SE, by each larval instar of three *Leucopis* populations. In each row, mean values followed by different lower case letters are different (df = 2, 28; $P < 0.001$; Scheffé's *F*-test), while in each column (within a stage or instar), mean values followed by different upper case letters are different (df = 2, 28; $P < 0.05$; Scheffé's *F*-test). The same letter or absence of lettering denotes no significant difference.

		L. ninae	*L. gaimarii* 'Central Ferry'	*L. gaimarii* 'Anatone'
1st instar:	20.0°C	5.13 ± 0.19	4.93 ± 0.23	5.00 ± 0.20
	23.3°C	4.60 ± 0.27	4.93 ± 0.21	4.73 ± 0.28
	26.6°C	5.20 ± 0.26	5.20 ± 0.24	5.07 ± 0.27
2nd instar:	20.0°C	13.60 ± 0.61	12.53 ± 0.51	12.40 ± 0.59
	23.3°C	13.00 ± 0.79	12.40 ± 0.45	11.13 ± 0.94
	26.6°C	11.60 ± 0.57	11.87 ± 0.39	12.40 ± 0.58
3rd instar:	20.0°C	68.40 ± 1.76 aA	76.20 ± 1.94 aA	100.87 ± 4.52 bA
	23.3°C	67.73 ± 4.60 aA	87.73 ± 4.12 b[1]B	77.60 ± 2.52 abB[2]
	26.6°C	79.67 ± 1.53 B	79.20 ± 3.59 AB	89.07 ± 2.50 B
total:	20.0°C	87.13 ± 1.86 a	93.60 ± 1.84 a	118.27 ± 4.67 b
	23.3°C	85.33 ± 4.46 a	105.07 ± 3.96 b[1]	93.47 ± 2.70 ab
	26.6°C	96.47 ± 1.85	96.27 ± 3.53	106.53 ± 2.69

[1] Different at $P < 0.005$; [2] Different at $P < 0.001$.

some variation with temperature. The number of nymphs consumed by *L. ninae* was higher at 26.6°C than at either 20.0°C ($F = 3.426$; $P < 0.05$) or 23.3°C ($F = 3.843$; $P < 0.05$). For *L. gaimarii* 'Central Ferry', the third instars consumed more aphid nymphs at 20.0°C than at 23.3°C ($F = 3.463$; $P < 0.05$). The highest number of aphid nymphs consumed was by third instars of *L. gaimarii* 'Anatone' at 20.0°C. They consumed more than those at either 23.3°C ($F = 13.354$) or 26.6°C ($F = 3.435$; $P < 0.05$).

At the three temperatures, the mean numbers of aphid nymphs consumed by various instars of the three species (Table 3) did not display a noticeable pattern. At the highest temperature (26.6°C), there were no statistical differences among the three species in the number of nymphs consumed during the larval stages. However, there were differences at the lower temperatures. For example, at 20.0°C, *L. gaimarii* 'Anatone' consumed more aphid nymphs during the third stadium than did either *L. ninae* ($F = 27.80$) or *L. gaimarii* 'Central Ferry' ($F = 16.05$), and larvae of *L. gaimarii* 'Anatone' consumed more total nymphs than did *L. ninae* ($F = 25.22$) or *L. gaimarii* 'Central Ferry' ($F = 15.83$). At 23.3°C, *L. gaimarii* 'Central Ferry' consumed more aphid nymphs than did *L. ninae* in the third stadium ($F = 7.31$; $P < 0.005$) and in the larval stage overall ($F = 7.66$; $P < 0.005$).

Discussion

Developmental times among the three populations did not differ at the two highest temperatures (23.3°C and 26.6°C). At the lowest temperature (20.0°C), however, *L. gaimarii* 'Anatone' required more time to complete the third stadium, coupled with consumption of many more aphid nymphs than either *L. ninae* or *L. gaimarii* 'Central Ferry'. In fact, *L. gaimarii* 'Anatone' consumed more aphid nymphs at 20.0°C than at 23.3°C or 26.6°C, and more than either of the other two at any temperature. This indicates that *L. gaimarii* 'Anatone' may be an effective predator at lower temperatures, with a lower feeding rate but higher total consumption.

Developmental times showed a consistent relationship with the rearing temperatures overall. For each of the three populations, the lowest number of days required to complete development was at the highest temperature (26.6°C). Each stadium was

shortened as the temperatures increased. From these results, one might infer that rearing *Leucopis* can be most quickly achieved at 26.6°C. However, at this high temperature, about half of the trials had to be restarted due to larval death during the first and second stadia. Larval death was less frequent (≈10–20%) at the two lower temperatures. Although not precisely quantified, these data suggest that larvae are less likely to survive at high temperatures (i.e. 26.6°C), but surviving larvae develop faster than conspecifics at lower temperatures. However, our study did not consider the microhabitat conditions in the field. Nor did we attempt to determine oviposition or other rearing factors at different temperatures.

An important finding from this study is that larvae of these *Leucopis* species are voracious predators on *D. noxia.* Larvae of the three populations developed rapidly in an artificial environment and may develop as quickly in the field, if a steady supply of aphids is available. For the three temperatures examined, aphid nymph consumption rates were affected by temperature. As temperature increased, feeding rates similarly increased for all three species, which was coupled with a decrease in the duration of the larval stage.

The information gained in this study is not intended to reflect the true conditions in the larval microhabitat, which are likely much different. Rather, the data serve as a general guideline for comparisons among the populations studied. These comparisons reflect the general feeding trends observed for two native populations of *L. gaimarii* and an exotic species, *L. ninae,* which has been introduced against *D. noxia* since 1991 in Arizona, California, Colorado, Idaho, Indiana, Kansas, Montana, Nebraska, New Mexico, Nevada, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming (Prokrym et al., in press). The results indicate that under these laboratory conditions the introduced exotic species and its native congener are at least equally effective in terms of larval feeding and development. Because the native species was found to be exploiting the pest resource in the field, i.e. the predator niche was already filled by a native, it seems more important to perform pre-release biological studies comparing its biology with the exotic. These studies should focus on potential advantages that the exotic species may have over its native congener against a particular pest. In this case, the exotic should be able to outperform the native in some aspects of their biology, for example, it should have more efficient feeding, faster development, higher fecundity, or be able to exploit the resource in some way that the native cannot.

This study also serves to further illustrate an idea considered by Gaimari and Turner (1996) based on immature morphology. The two populations of *L. gaimarii* can be distinguished in the immature stages (Gaimari and Turner 1996), while the adults are apparently indistinguishable morphologically (Tanasijtshuk 1996). The current study provides further evidence that the two populations of *L. gaimarii* are distinct, because the 'Anatone' population had a significantly longer developmental period and consumed more total prey at the lowest experimental temperature than did the 'Central Ferry' population. Although we are not suggesting that these populations should be accorded species rank, these biological differences can be considered in an evolutionary context. As was suggested by Gaimari and Turner (1996), the two populations could have recently become separated, perhaps due to host or elevational preferences, and had begun to diverge when *D. noxia* entered the region and provided a suitable, unexploited resource for both of them. Certain developmental differences could have already become established and were partly reflected in this study.

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NEPALOZONIUM TRIMACULATUM, N. GEN., N. SP. (DIPLOPODA: POLYZONIIDA: HIRUDISOMATIDAE): FIRST RECORD OF THE ORDER AND FAMILY FROM CENTRAL ASIA

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Abstract.—***Nepalozonium trimaculatum,*** n. gen., n. sp., the first record of the diplopod order Polyzoniida and the family Hirudisomatidae from central Asia, is described from Yangri Ridge (4700–4800 m (15,416–15,744 ft)), in the Himalaya Mountains ca. 40 km (25 mi) NNE Kathmandu, Nepal. Additional species of *Nepalozonium* may occur at high elevations in montane regions of Nepal and neighboring countries.

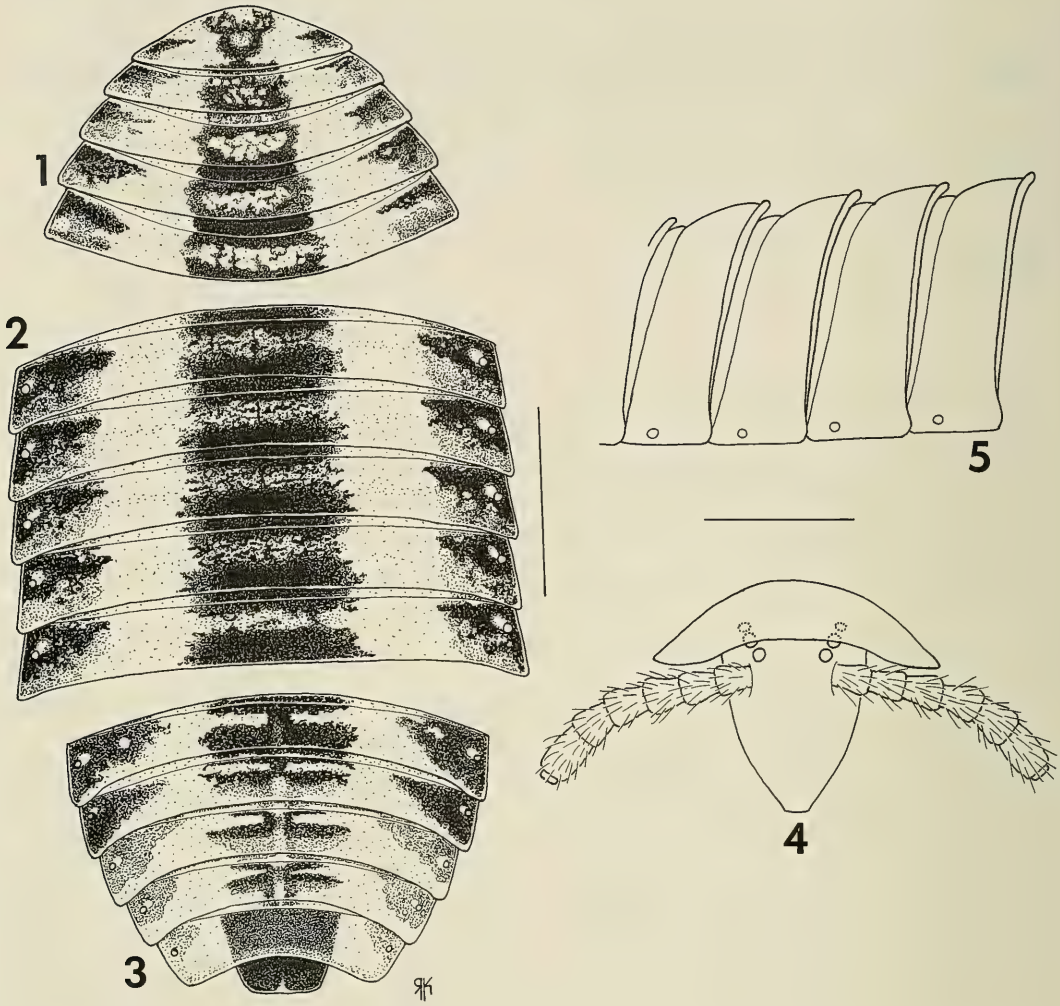
Key Words: Polyzoniida, Hirudisomatidae, *Nepalozonium,* Himalayas, Nepal

The Holarctic milliped family Hirudisomatidae (order Polyzoniida) is currently represented by *Hirudisoma* Fanzago in Europe (Portugal, the Pyrenees of France, Italy, Slovenia, Greece, and Turkey), *Octoglena* Wood in North America (the eastern and western United States and British Columbia, Canada), *Mexiconium* Shelley in Mexico, and *Orsiboe* Attems and *Kiusiozonium* Verhoeff in Japan (Mauriès 1964, Hoffman 1980, Shelley 1996), although *Orsiboe* may represent another family (Hoffman, pers. comm.). I report here the first representative of the order and family from Central Asia, the Himalaya Mountains, and Nepal based on a sample with two males housed in the Canadian National Collection (CNC), Agriculture Canada, Ottawa, Ontario; to the best of my knowledge, the closest ordinal record to Nepal is that of *Siphonocryptus latior* Enghoff and Golovatch (family Siphonocryptidae) from Malaya. The specimens lack the middorsal suture of the Siphonocryptidae (Enghoff and Golovatch 1995) and demonstrate diagnostic features of the Hirudisomatidae including elevation of the caudal metatergal margins above the succeeding tergites and the caudoventral location of the penes on the 2nd male coxae (Figs. 5–6) (Shelley 1995). In contrast to species of *Hirudisoma* and *Octoglena* (Enghoff and Golovatch 1995, Shelley 1995), the penes of these individuals are "bottle shaped" rather than subconical, but they are located at the typical position for the family. I thank R. Footit and L. LeSage, for loans of the sample; A. Smetana, the collector, for information on the locality; and R. G. Kuhler, for preparing figures 1–5.

Nepalozonium Shelley, new genus

Type species.—*Nepalozonium trimaculatum,* new species.

Diagnosis.—Dorsum smooth, polished; caudal metatergal margins detached from and elevated above succeeding tergites; body broad (W/L ratio 37–47%) and "bell shaped," sides extending strongly laterad; collum broad, overhanging epicranium and at least one pair of ocelli; caudolateral corners of midbody and caudal segments extending slightly caudad; telson relatively

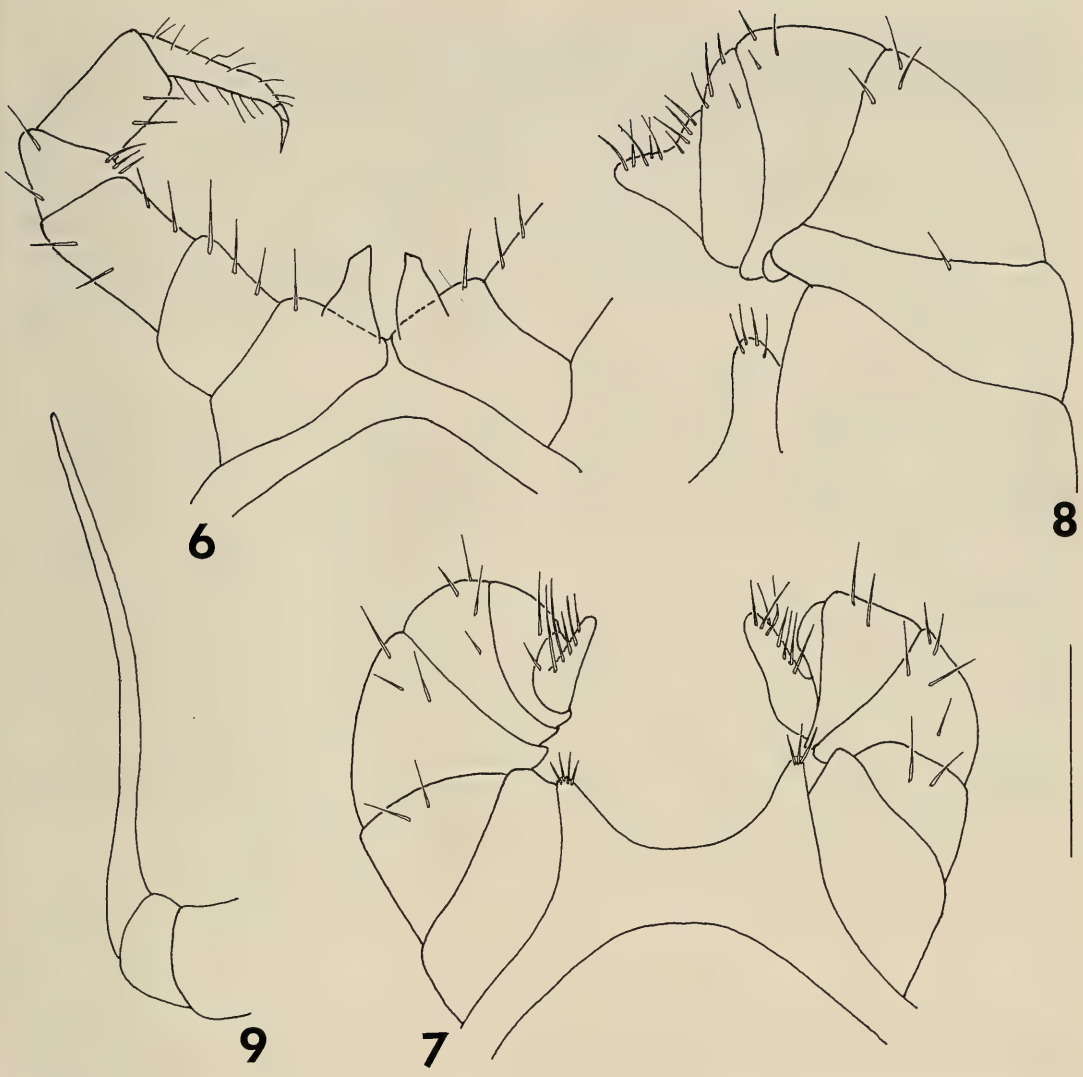


Figs. 1–5. *Nepalozonium trimaculatum* holotype, somatic features. 1–3, Dorsal views of (1) anterior, (2) midbody, and (3) caudal segments. 4, Head, antennae, and collum, anterior view. 5, Midbody segments, lateral view of left side. Scale line for figs. 1–3 = 0.5 mm for each; line for figs. 4–5 = 0.5 mm for each.

narrow, comprising around half of caudal width; head subtriangular, with three ocelli on each side arranged linearly in angular rows beginning at levels of antennal sockets; penes broad basally, narrowing abruptly distad, located slightly caudoventrad on 2nd male coxae; sternum of anterior gonopods with widely separated, subconical, apically hirsute lobes; anterior gonopods curving strongly anteriad distad, ultimate podomere prolonged and moderately hirsute, apically blunt, directed subanteromediad; corners of 2nd to 4th podomeres slightly extended on caudal side; coxa with anteromedial side slightly longer but without lobe; posterior gonopod with ultimate podomere simple and acicular, apically acuminate.

Distribution.—Known only from central Nepal.

Species.—One is known; others may exist in remote pockets at high elevations in Nepal, Bhutan, India, Tibet/China, Pakistan, Afghanistan, Tajikistan, and Kyrgyzstan.



Figs. 6–9. *Nepalozonium trimaculatum* holotype, sexual features. 6, Penes, 2nd coxae, and right 2nd leg, caudal view. 7, Anterior gonopods and sternum, anterior view. 8, Left anterior gonopod, caudal view. 9, Distal podomeres of left posterior gonopod, caudal view. Scale line = 0.5 mm for each fig.

Nepalozonium trimaculatum Shelley, new species
(Figs. 1–9)

Type specimens.—♂ holotype and ♂ paratype (CNC) collected by A. Smetana, 22 April 1981, along Yangri Ridge, ca. 40 km (25 mi) NNE Kathmandu, Nepal. Yangri Ridge lies east of the Malemchi River and extends northward from Yangri Mountain to the east-west ridge connecting Mts. Ganja La (5846 m (19,174 ft)) and Ponggen Dopku (5930 m (19,450 ft)) (see Smetana 1988, map 2).

Diagnosis.—With the characters of the genus (Figs. 4–9).

Color.—The base color is light yellow, and there are three dark spots on each pro- and metatergite that coalesce with those on adjacent tergites and form longitudinal stripes, the darkest one in the midline and lighter, mottled spots along the lateral mar-

gins (Figs. 1–3). The spots are considerably lighter on the caudal three tergites, and the ultimate one is translucent, revealing the dark pigmentation of the telson beneath it. This pigmentation pattern may be diagnostic of the genus or this species, and *Nepalozonium* may be similar to *Octoglena* Wood, which includes four unpigmented species and one with three dorsal stripes (Shelley 1995).

Variation.—The gonopods of the holotype and paratype are virtually identical. Excluding the telson, the holotype has 27 segments and measures 4.3 mm in length and 2.0 mm in width (W/L ratio 46.5%); the paratype has 22 segments and measures 3.7 mm in length and 1.4 mm in width (W/L ratio 37.8%).

Ecology.—The specimens were encountered at an elevation of 4700–4800 m (15,416–15,744 ft). The habitat is not indicated on the vial label, but this elevation is in the subalpine/alpine tundra zone, which is characterized by moss and dwarf azalea bushes (*Rhododendron* sp.) (Smetana, pers. comm.). According to Smetana (1988) the staphylinid beetles, *Quedius* (*Microsaurus*) *franzi* Smetana and *Q.* (*M.*) *angnimai* Smetana, were collected on Yangri Ridge on 21–22 April 1981 by sifting moss, debris, and fallen leaves under low bushes and dead vegetation/grass along the bases of large rocks in a pasture above the tree line. The specimens of *N. trimaculatum* were encountered during this sifting.

Distribution.—Known only from the type locality.

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LIFE HISTORY AND DESCRIPTIONS OF ADULTS AND IMMATURE STAGES OF *ACIURINA IDAHOENSIS* STEYSKAL (DIPTERA: TEPHRITIDAE) ON *CHRYSOTHAMNUS VISCIDIFLORUS* (HOOKER) NUTTALL IN SOUTHERN CALIFORNIA

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Abstract.—*Aciurina idahoensis* Steyskal is a univoltine, monophagous fruit fly that forms distinctive, leafy, axillary bud galls on *Chrysothamnus viscidiflorus* (Hooker) Nuttall, its only known host plant, throughout the western United States. Documentation is provided for the first time for the genus *Aciurina,* and more importantly, for the family Tephritidae as a whole, that the wing patterns of the adults of this species are strongly sexually dimorphic in southern California, but not dimorphic, or much less strongly or consistently so, in other parts of its range, e.g., in Idaho. The egg, first through third instars, and puparium of *A. idahoensis* are described, illustrated, and compared with other southern California *Aciurina* spp. The egg has a long pedicel with a knoblike, anterior apex. The third instar is characterized by having only one row of verruciform sensilla circumscribing the prothorax and no abdominal lateral spiracular sensilla. *Aciurina idahoensis* co-occurs with *A. semilucida* (Bates) on *C. viscidiflorus* at lower altitudes (<1800 m) in southern California; whereas, this host plant is partitioned altitudinally and shared by *A. ferruginea* (Doane) and *A. michaeli* Goeden at higher altitudes (>2100 m).

Key Words: Insecta, *Aciurina, Chrysothamnus,* biology, galls, regional sexual dimorphism, adult taxonomy, immature taxonomy, parasitoids

Six *Aciurina* spp. (Diptera: Tephritidae) forming galls on *Chrysothamnus* or *Baccharis* spp. (Asteraceae) in southern California have been studied by us in recent years. This paper follows those on *A. thoracica* Curran (Headrick and Goeden 1993), *A. ferruginea* (Doane), and *A. michaeli* Goeden (Goeden and Teerink 1996) in a series projected to treat at least two more southern California species of *Aciurina.* Herein, we describe our findings to date on the tephritid that Wangberg (1981) called "*Aciurina* sp. A" and Steyskal (1984) named *A. idahoensis* Steyskal.

MATERIALS AND METHODS

Our field studies were conducted on *Chrysothamnus viscidiflorus* (Hooker) Nuttall (Asteraceae) in Deep Spring Valley, the southernmost extension of the Great Basin biome (Munz 1974, Hall 1991), located northeast of the Westgard Pass in the White-Inyo Mountain Range, Inyo Co., California. Galls containing larvae and puparia of *A. idahoensis* were sampled from plants in Payson Canyon at 1770 m at the southwest end of the Valley during March–June, 1992–94. Excised galls were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Ten ova dissected from mature females and 16 larvae and 4 puparia dissected from galls were preserved in 70% EtOH for scanning

electron microscopy (SEM). All other fully grown larvae and puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM later were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24 h, dehydrated through an increasing series of acidulated EtOH, critically point dried, mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screened-top cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cagings were used for longevity studies and oviposition tests in the insectary of the Department of Entomology, University of California, Riverside, at 25 ± 1°C, and 14/10 (L/D) photoperiod. Virgin male and female flies obtained from emergence vials as well as field-swept adults were paired in clear-plastic petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey (Headrick and Goeden 1991) for direct observations, videorecording, and still-photography of their courtship and copulation behavior to be reported elsewhere (Headrick and Goeden, unpublished data).

Plant names used in this paper follow Munz (1974); tephritid names and nomenclature follow Foote et al. (1993). Morphological terminology and telegraphic format used to describe the immature stages follows Headrick and Goeden (1993), Goeden et al. (1993, 1994a, b, 1995a, b), Goeden and Teerink (1996), and our earlier works cited therein. Means ± SE are used throughout this paper. Voucher specimens of reared adults of *A. idahoensis* and its parasitoids reside in the research collections of RDG; preserved specimens of eggs, larvae, and puparia are stored in the research collection of JAT.

Results and Discussion

Taxonomy

Adult.—*Aciurina idahoensis* was described by Steyskal (1984) from specimens of what he suggested were "likely" both *Aciurina* sp. A and sp. B of Wangberg (1981). However, Goeden and Teerink (1996) demonstrated conclusively that *Aciurina* sp. B was *A. ferruginea,* and described the maker of the gall formerly attributed to *A. ferruginea* (Tauber and Tauber 1967, Wangberg 1981) as *A. michaeli* Goeden. Thus, only the *Aciurina* sp. A of Wangberg (1981) is *A. idahoensis* (Steyskal 1984, Foote et al. 1993, Goeden and Teerink 1996).

Steyskal (1984) in describing *A. idahoensis* from specimens from Idaho, from where it then solely was known (Foote et al. 1993), was unaware that the adults of this species show strong sexual dimorphism in their wing patterns elsewhere, e.g., in southern California, from where we now also report this species. Photographs are provided of the right wings of specimens of a male (Fig. 1A) and female (Fig. 1B) from Idaho comparable to those of paratypes obtained from the U.S. National Museum of Natural History, Washington, DC, and to the majority [70 (75%)] of 93 ♂ and [57 (78%)] of 73 ♀ from Idaho examined from the W. F. Barr Entomological Museum Collection, University of Idaho. Figure 1A also is comparable to the single photograph of a right wing of *A. idahoensis* (sex unstated) in Foote et al. (1993); whereas, Fig. 1B is comparable to "a variation found in ♂ specimens", and the only wing photograph provided of *A. idahoensis* by Steyskal (1984). Compare the preceding wing patterns with those of male (Fig. 1C) and female (Fig. 1D) *A. idahoensis* individually reared from galls like those described and illustrated by Wangberg (1981) for *Aciurina* sp. A and swept from *C. viscidiflorus* at our study site in Deep Spring Valley, Califor-

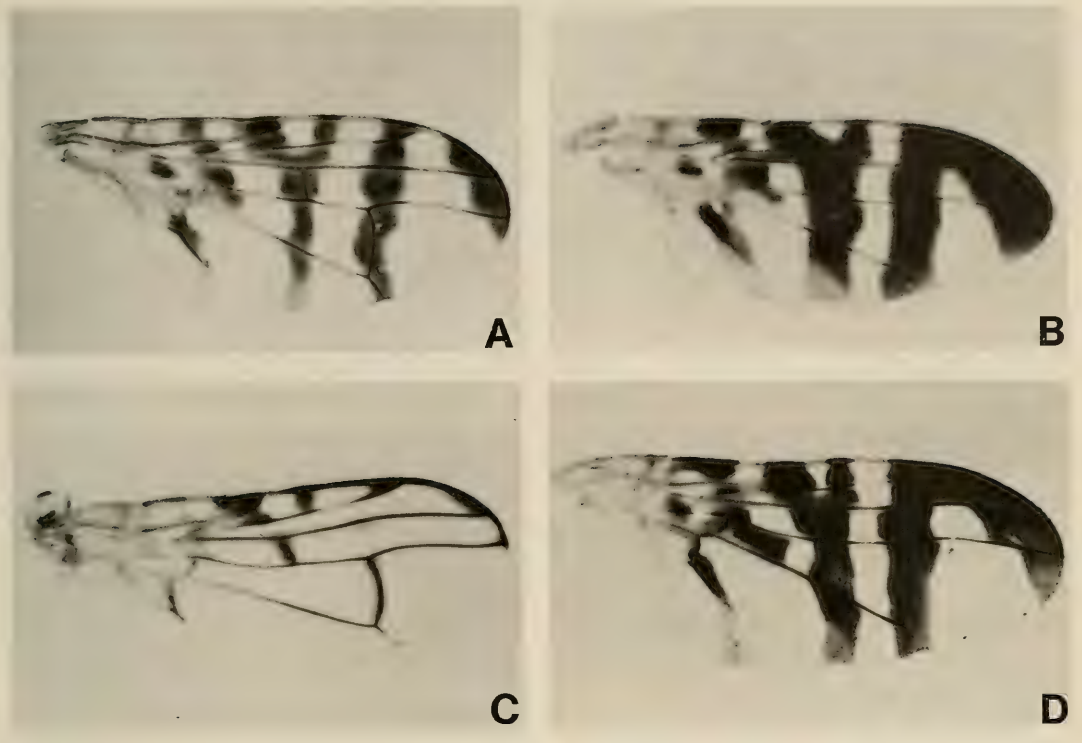

Fig. 1. Right wings of *Aciurina idahoensis:* (A) male from Idaho, (B) female from Idaho, (C) male from California, (D) female from California.

nia. These photographs document for the first time the pronounced regional variation in the wing patterns of *A. idahoensis* within its range in North America. This variation is of such magnitude that the strong sexual dimorphism in wing patterns that occurs in California is absent, or much less strongly or consistently expressed, between the sexes in Idaho (see below). Goeden and Teerink (1996) first reported the incidence of sexual dimorphism among *Aciurina* spp. in the wing patterns of both *A. ferruginea* and *A. michaeli,* but this variation between the sexes of these two species pales in comparison to that shown by *A. idahoensis* in California (Fig. 1C and D). Sexual dimorphism also is known to occur in *A. semilucida* (Bates) in California (Goeden and Teerink, unpublished data), and will be described separately in our next paper. The discovery of regional sexually dimorphic wing patterns helps to explain the highly variable nature of the dark markings in the wing patterns of flies lumped together as *A. bigeloviae* by Steyskal (1984) and Foote et al. (1993).

In the wings of all 12 males of *A. idahoensis* examined from California, the median dark area in cell c (Fig. 1A) is absent (Fig. 1C). Also, the dark crossband otherwise passing through vein r-m in Idaho specimens (Fig. 1A) is reduced in California males to a dark spot wholly or partly covering this vein (Fig. 1C), and its anterior bifurcation is reduced to a dark spot in the pterostigma (Fig. 1C), and a dark spot on the costa apicad of R_1 (Fig. 1C). The complete crossband running through vein dm-cu without an accessory arm in Idaho specimens (Fig. 1A) is reduced in California males to a slight darkening of the apex of cell r_1, or at least to a darkening of the apices of vein R_{2+3} and costa at this juncture (Fig. 1C), as well as the apex of vein

dm-cu (Fig. 1C). Furthermore, the apicocostal band present in Idaho specimens (Fig. 1A) is reduced in California males to a slight darkening of apices of cells r_{2+3} and r_{4+5} at the apices of veins R_{4+5} and M, respectively, along the costa (Fig. 1C). Because the pterostigma of these 12 males from California was no more than 1.5 times as long as its greatest width (Fig. 1C), rather than at least twice as long as its greatest width as in *A. bigeloviae,* these males key to *A. notata* (Coquillett) in the keys of Steyskal (1984) and Foote et al. (1993). Were it not that the rare species, *A. notata* (Foote et al. 1993), was described from a female (Coquillett 1899) with a wing pattern totally disimilar from those illustrated in Fig. 1B and 1D, remains known only from New Mexico (Foote et al. 1993), and was reported from a different type of gall on a different host [*C. nauseosus* (Pallen) Britton, Cockerell 1900], we might have suggested that California *A. idahoensis* males were in fact *A. notata.* Instead, we now merely note that male *A. idahoensis* from California also run to *A. notata* in the key to the North American *Aciurina* in Foote et al. (1993), though based on the following findings remain readily separable by their different galls and host plants.

After examination of the types of *A. notata* from Albuquerque, New Mexico, galls of this species collected by Cockerell (1900) from Santa Fe, New Mexico, and seven other specimens of adults reared from the latter galls, Bates (1935) concluded that both adults and galls, though similar, were distinct from those of *A. semilucida* (Bates), a rare species in southern California to be discussed in our next paper in this series (Goeden and Teerink, unpublished data). And, Bates (1935) noted that some of these specimens of *A. notata* had a wing pattern "... reduced to a few small brown spots as described (but not illustrated) by Coquillett. . ..(our parentheses)" (1899). We, too, after examination confirm that two of the galls of *A. notata* collected by Cockerell (1900) from *A. nauseosus,* apparently among those examined by Bates (1935), are very different from those of *A. idahoensis* described herein, from the gall mounted with a paratype of *A. semilucida,* and from series of galls of *A. semilucida* examined by us from Idaho and southern California (Goeden and Teerink, unpublished data). Furthermore, a male specimen of *A. notata* from Cockerell's (1900) series from Santa Fe, also presumably among those examined by Bates (1935) appears much like the lightest wing pattern illustrated for *A. notata* by Steyskal (1984), the wing pattern for *A. notata* figured in Foote et al. (1993), as well as the male of *A. idahoensis* from California (Fig. 1C).

Variations also were found within and between sexes in specimens of *A. idahoensis* from Idaho and California that temper characters used in the keys of Steyskal (1984) and Foote et al. (1993). Steyskal (1984) stated that the apicocostal band usually is separated from the transverse band through vein dm-cu in males from Idaho. Fifteen (16%) of the 93 ♂ examined from Idaho, like most females (Fig. 1B), had wings with these bands joined; whereas, in 14 (19%) of the 73 ♀, like most males (Fig. 1A), these bands were distinctly separated. One female each from California and Idaho (a non-paratype) had the apicocostal band connected along vein CuA_1, as noted for one paratype by Steyskal (1984). Additional variations noted by us among specimens from Idaho were five males in which the crossband through vein r-m was broken in cell dm, two other males in which the apicocostal band was broken in cell r_{4+5}, leaving a dark spot at the end of vein M, and one male with a faint, round spot at the apicocentral margin of cell m.

Immature stages.—*Egg.*—Ova (Fig. 2A) white, opaque, smooth; with an elongate-ellipsoidal body, 0.51 ± 0.007 (range, 0.44–0.56) mm long, 0.19 ± 0.002 (range, 0.16–0.20) mm wide (n = 25), smoothly rounded at tapered posterior end; and with an elongate, anterior pedicel, 0.37 ± 0.006 (range, 0.26–0.40) mm long, 0.01 mm wide

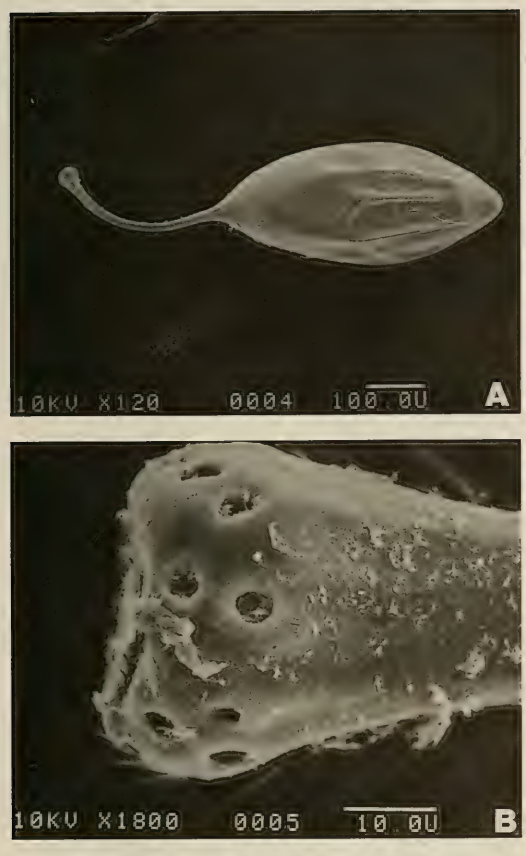

Fig. 2. Egg of *Aciurina idahoensis:* (A) habitus, (B) apex of pedicel.

medially, and 0.04 mm wide at knoblike, anterior apex (Fig. 2B).

The eggs of *A. idahoensis* are stalked like those of *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996), all three of which differ greatly in appearance from the short-pedicelled, partly reticulated egg of *A. thoracica* (Headrick and Goeden 1993). The respiratory function of the elongate pedicel of these eggs was first suggested for *A. michaeli* by Tauber and Tauber (1967) and was supported with morphological and biological data by Goeden and Teerink (1996). The egg bodies and pedicels of *A. idahoensis* are shorter on average than these parts of the eggs of both *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996).

Third instar.—Superficially smooth, ovoidal, anteriorly and posteriorly rounded, minute acanthae ventrally (Fig. 3A); gnathocephalon conical, rugose pads laterad of mouth lumen; pair of elongated dorsal petals near mouth lumen (Fig. 3B-1); paired dorsal sensory organs dorsomediad of anterior sensory lobes, each consisting of a dome-shaped papilla (Fig. 3B-2, C-1); anterior sensory lobes bear the terminal sensory organ (Fig. 3C-2), pit sensory organ (Fig. 3C-3), lateral sensory organ (Fig. 3C-4), and supralateral sensory organ (Fig. 3C-5); stomal sense organs ventrolaterad of anterior sensory lobes, near mouth lumen (Fig. 3B-3, D-1); lateral sensillum located laterad of anterior sensory lobe (Fig. 3B-4), ventrolateral sensillum located ventrolaterad of stomal sense organs, each consisting of a verruciform sensillum; mouth hooks tridentate, medial tooth reduced, teeth conical, rounded apically (Fig. 3D-2); median oral lobe tapered anteriorly, flattened ventrally, attached to labial lobe (Fig. 3D-3); prothorax smooth, minute acanthae ventrally, verruciform sensilla circumscribe prothorax; anterior thoracic spiracles dorsolateral on posterior margin of prothorax, consisting of 3–5 oval papillae (Fig. 3E); metathoracic lateral spiracular complex consists of an open spiracle (Fig. 3F-1), and single verruciform sensillum (Fig. 3F-2); abdominal lateral spiracular complex consists of open spiracle; caudal segment bears posterior spiracular plates (Fig. 3G-1, H); posterior spiracular plates with three oval rimae, ca. 0.032 mm in length (Fig. 3H-1), and four interspiracular processes with 2–4 branches each, longest measuring 0.013 mm (Fig. 3H-2); two compound sensilla ventrad of posterior spiracular plates consist of a stelex sensillum (Fig. 3G-2), and a verruciform sensillum (Fig. 3G-3); stelex sensilla surround margin of caudal segment in a 2-dorsal, 4-ventral arrangement (Fig. 3G-4).

Aciurina idahoensis closely resembles *A. ferruginea* and *A. thoracica* in general habitus (Goeden and Teerink 1996, Headrick and Goeden 1993). These three species differ from *A. michaeli* which is expanded

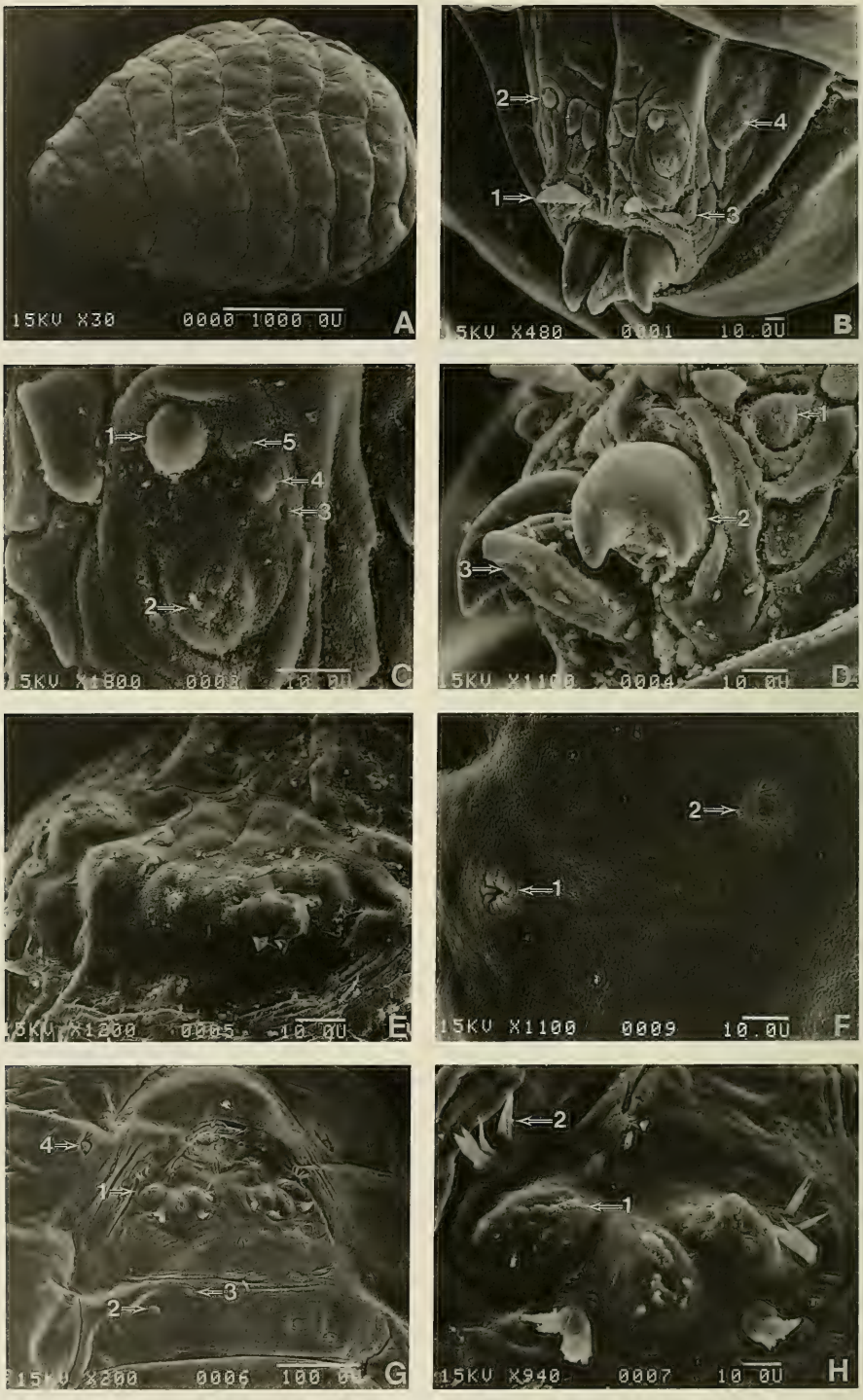

Fig. 3. Third instar of *Aciurina idahoensis:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—elongated dorsal petal, 2—dorsal sensory organ, 3—stomal sense organ, 4—lateral sensillum; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ; (D) gnathocephalon, ventrolateral view, 1—stomal sense organ, 2—mouth hooks, 3—median oral lobe; (E) anterior thoracic spiracle; (F) metathoracic lateral spiracular complex, 1—

dorsally in abdominal segments III–V forming a distinct hump (Goeden and Teerink 1996). *Aciurina idahoensis* differs from *A. thoracica* in having only one row of verruciform sensilla circumscribing the prothorax, no abdominal lateral spiracular sensilla, and larger branched interspiracular processes (Headrick and Goeden 1993). *Aciurina ferruginea* differs from *A. idahoensis* in having serrated rugose pads laterad of the mouth lumen, three metathoracic lateral spiracular sensilla, and many-branched interspiracular processes (Goeden and Teerink 1996).

Second instar.—Superficially smooth, ovoidal, anteriorly and posteriorly rounded, with minute acanthae ventrally and laterally along abdominal segment lines (Fig. 4A); gnathocephalon conical, rugose pads laterad of mouth lumen; paired dorsal sensory organs dorsomediad of anterior sensory lobes (Fig. 4B-1, C-1); anterior sensory lobes (Fig. 4B-2, C) bear the terminal sensory organ (Fig. 4C-2), pit sensory organ (Fig. 4C-3), lateral sensory organ (Fig. 4C-4), and supralateral sensory organ; stomal sense organs ventrolaterad of anterior sensory lobes (Fig. 4B-3, D-1); lateral sensillum laterad of anterior sensory lobes (Fig. 4B-4, D-2), ventrolateral sensillum ventrolaterad of stomal sense organs (Fig. 4D-3), each consisting of a verruciform sensillum; mouth hooks bidentate, lateral tooth small (Fig. 4D-4); median oral lobe rounded anteriorly, attached to labial lobe (Fig. 4D-5); labial lobe bears two pore sensilla (Fig. 4D-6); prothorax smooth, minute acanthae ventrally, verruciform sensilla circumscribe segment; anterior thoracic spiracles dorsolateral on posterior margin of prothorax, each consisting of 3–5 oval papillae (Fig. 4E); thoracic lateral spiracular complexes not observed; abdominal lateral spiracular complex consist of an open spiracle (Fig. 4F); caudal segment bears posterior spiracular plates (Fig. 4G-1); posterior spiracular plates bear three oval rimae and four interspiracular processes (structures obscured in Fig. 4G); compound sensilla ventrad of posterior spiracular plates (Fig. 4G-2), consist of a stelex sensillum (Fig. 4H-1) and a raised, verruciform sensillum (Fig. 4H-2) in one pair of sensilla, and two raised verruciform sensilla in the other; stelex sensilla surround caudal segment in 2-dorsal, 4-ventral arrangement (Fig. 4G-3).

The second instar closely resembles the third instar in general habitus. Most morphological features of the second instar are similar in shape and placement to those of the third instar with a few exceptions. Minute acanthae along segmental lines are more noticeable in the second instar. The gnathocephalon differs slightly from the third instar. The pair of elongated dorsal petals present in the third instar are not found in the second instar. The mouth hooks are bidentate in the second instar. On the caudal segment, the compound sensilla ventrad of the posterior spiracular plates contain only one raised verruciform sensillum in one of the pairs, whereas those in the third instar consist of a stelex sensillum and a verruciform sensillum in both pairs.

First instar.—Superficially smooth, oblong-spheroidal, anteriorly and posteriorly rounded, minute acanthae circumscribing segmental lines (Fig. 5A); gnathocephalon conical, smooth, lacking rugose pads (Fig. 5B); pair of dorsal petals near mouth lumen (Fig. 5B-1); paired dorsal sensory organs dorsomediad of anterior sensory lobes (Fig. 5B-2, C-1); anterior sensory lobes bear terminal sensory organ (Fig. 5C-2), lateral sensory organ (Fig. 5C-3) (pit sensory organ not observed), and supralateral sensory

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spiracle, 2—verruciform sensillum; (G) caudal segment, 1—posterior spiracular plates, 2—compound sensillum, stelex sensillum, 3—compound sensillum, verruciform sensillum, 4—stelex sensillum; (H) posterior spiracular plate, 1—rima, 2—interspiracular process.

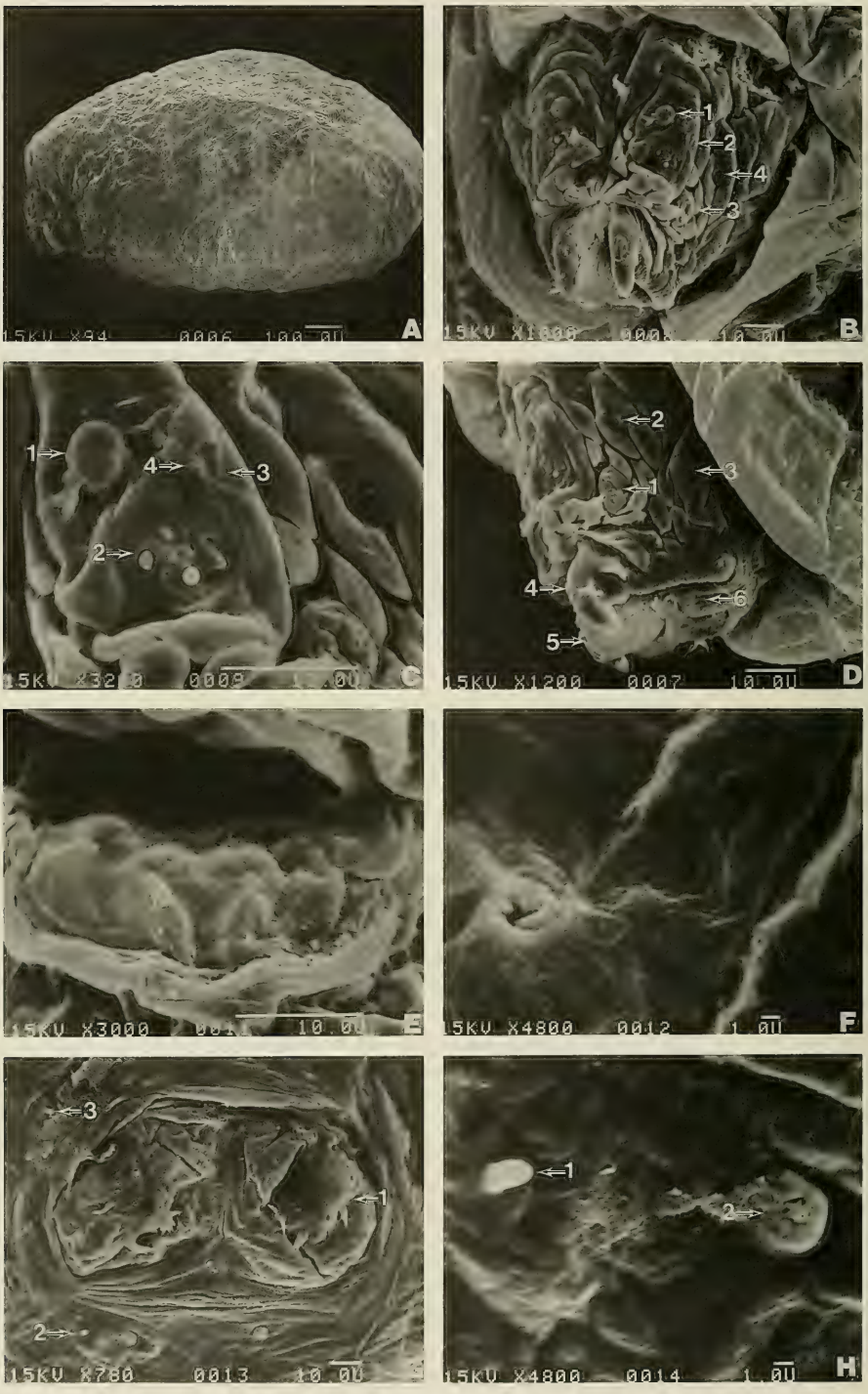

Fig. 4. Second instar of *Aciurina idahoensis:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—anterior sensory lobe, 3—stomal sense organ, 4—lateral sensillum; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ; (D) gnathocephalon, ventrolateral view, 1—stomal sense organ, 2—lateral sensillum, 3—ventrolateral sensillum, 4—mouth hooks, 5—median oral lobe, 6—labial lobe sensilla; (E) anterior thoracic spiracle; (F)

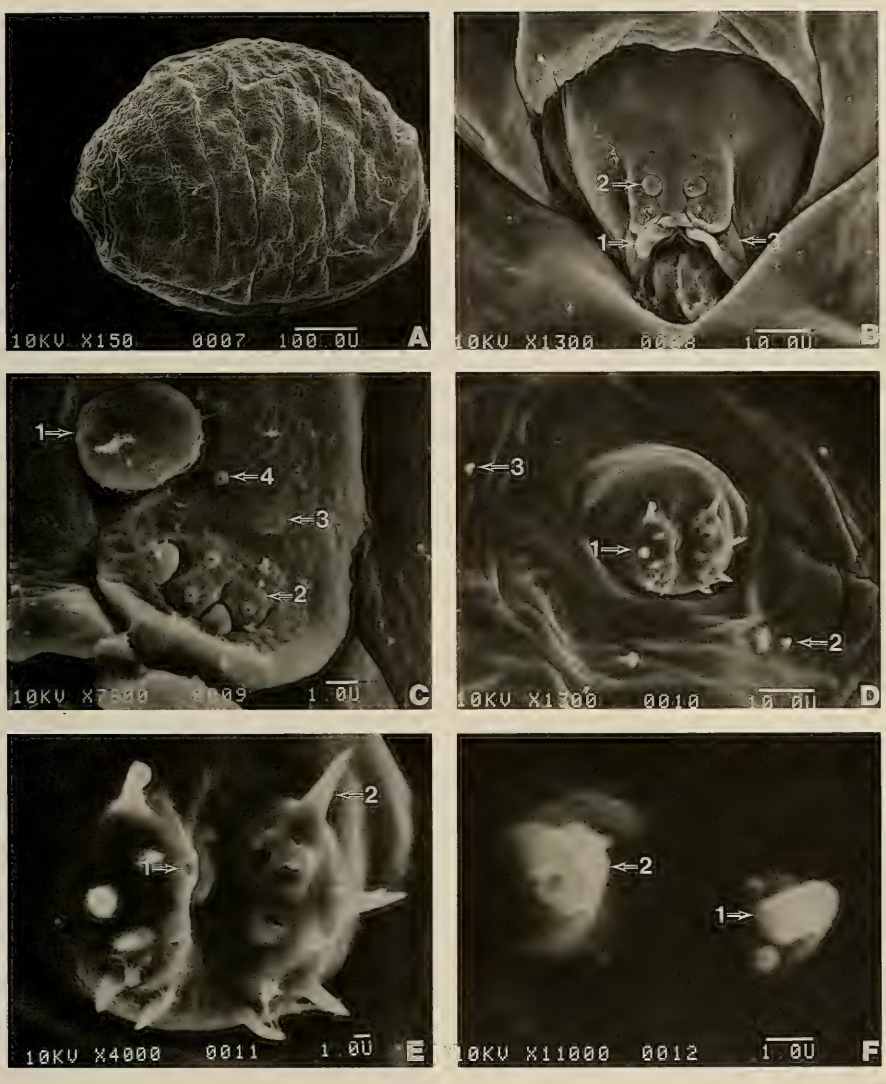

Fig. 5. First instar of *Aciurina idahoensis:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—dorsal petal, 2—dorsal sensory organ, 3—stomal sense organ; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—lateral sensory organ, 4—supralateral sensory organ; (D) caudal segment, 1—posterior spiracular plate, 2—compound sensilla, 3—stelex sensillum; (E) posterior spiracular plate, 1—rima, 2—interspiracular process; (F) compound sensillum, 1—stelex sensillum, 2—tuberculate, medusoid chemosensillum.

organ (Fig. 5C-4); stomal sense organs ventrolaterad of anterior sensory lobes indistinct (Fig. 5B-3); lateral and ventral sensilla indistinct; mouth hooks were not visible; median oral lobe obscured; prothorax smooth, lacks minute acanthae ventrally; anterior thoracic spiracles absent; lateral spiracular complex not observed; caudal

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abdominal lateral spiracle; (G) caudal segment, 1—posterior spiracular plates, 2—compound sensillum, 3—stelex sensillum; (H) compound sensillum, 1—stelex sensillum, 2—verruciform sensillum.

segment bears posterior spiracular plates (Fig. 5D-1); posterior spiracular plates bear two round rimae, ca. 0.002 mm in length (Fig. 5E-1), and four interspiracular processes, longest measuring 0.005 mm in length (Fig. 5E-2); compound sensilla ventrad of posterior spiracular plates consist of a stelex sensillum (Fig. 5F-1), and a tuberculate medusoid chemosensillum (Fig. 5F-2) in one sensillum and a tuberculate medusoid chemosensillum in the other (Fig. 5D-2); stelex sensilla surround margin of caudal segment in a 2-dorsal, 4-ventral arrangement (Fig. 5D-3).

First instars differ from the second and third instars in general habitus, being more spheroidal in shape. The minute acanthae are limited to the segmental lines, but circumscribe the segments. The gnathocephalon is quite different from the other two instars. The first instar is smooth, lacking rugose pads, the anterior sensory lobes and stomal sense organs are not as well-defined, and the lateral and ventrolateral sensilla are not present. Unfortunately, the mouth hooks and median oral lobe were not visible in the single prepared specimen. The first instar lacks anterior thoracic spiracles and the lateral spiracular complex was not observed. The compound sensilla ventrad of the posterior spiracular plates are more distinct than in the other two instars. The first instar larva of *A. idahoensis* closely resembles that of *A. ferruginea* (Goeden and Teerink 1996).

Puparium.—Smooth, elongate-reniform, reddish-brown (Fig. 6A); anterior end bears anterior thoracic spiracles (Fig. 6B-1), invagination scar (Fig. 6B-2), and verruciform sensilla (Fig. 6B-3); caudal end bears posterior spiracular plates (Fig. 6C); posterior spiracular plates bear three oval rimae, ca. 0.052 mm in length (Fig. 6C-1), and four interspiracular processes (Fig. 6C-2). Nineteen averaged 3.84 ± 0.17 (range, 3.18–6.72) mm in length and 1.92 ± 0.04 (range, 1.67–2.32) mm in width.

Fig. 6. Puparium of *Aciurina idahoensis:* (A) habitus, anterior to left; (B) anterior end, 1—anterior thoracic spiracle, 2—invagination sear, 3—verruciform sensillum; (C) caudal end, posterior spiracular plate, 1—rima, 2—interspiracular process.

Distribution and Hosts

Heretofore, *A. idahoensis* was known only from Idaho (Steyskal 1984, Foote et al. 1993); however, its distribution probably

parallels that of its sole host plant, *C. viscidiflorus,* first reported by Wangberg (1981) for "*Aciurina* sp. A" to include both "ssp. *viscidiflorus* (Eaton) and ssp. *stenophyllus* (Gray)". Wangberg (1981) remarked that ". . . this species was common throughout southern Idaho and often abundant at various sites, . . ." and that its distribution ". . . appears continuous and coextensive with its host plant." *Aciurina idahoensis* has only been found in Deep Spring Valley in California.

Biology

Egg.—Eggs are deposited singly in axillary or (rarely) terminal buds of the current year's branch growth, judging from the occurrence of only one larva per gall and the sessile nature of the gall, indicative of little bud growth at the time of oviposition. The stalked eggs of *A. idahoensis,* like those of *A. ferruginea* and *A. michaeli,* suggest an adaptation for respiration in resin-covered buds of their common host plant (Goeden and Teerink 1996). Young galls bearing second instars (Fig. 7A) collected in late March in southern California bore many dead basal leaves indicative of earlier gall growth and first-instar larval development during the previous year, probably progressing very slowly since oviposition in late-spring (May–June), and egg eclosion sometime during the subsequent summer or fall, then overwintering (July–February) until rapid concurrent host-plant, gall, and insect growth accelerate in the following spring (March–May). Thus, in our opinion, the overwintering stage is the first instar. Wangberg (1981), instead, inferred the egg stage to last ca. 320 days in Idaho ". . . based on the time of adult emergence and the first signs of gall growth." Detection of the earliest stages of *Aciurina* spp. gall development and ascertaining the overwintering stage(s) are difficult (Goeden and Teerink 1996), and are further complicated by the presence of at least four species of *Aciurina* and one species of *Procecidochares* (Diptera: Tephritidae) as well as Lepidoptera and Cecidomyiidae, all forming bud galls on *C. viscidiflorus* (Wangberg 1980, 1981; Goeden and Teerink 1996, unpublished data).

Larva.—The gall of *A. idahoensis* is a stunted axillary branch, or rarely a branch apex, reminescent of a pine cone (Steyskal 1984). As such, it is subspheroidal when young (Fig. 7A), elongating into an ovoid as it grows and matures (Fig. 7D, E). The gall also bears basally expanded, sessile, linearly tapered, and apically pointed, smooth-margined leaves, which are shortened and more densely packed apically (Fig. 7E). The oldest, basal, overwintered leaves were dead and tan (Fig. 7A, B); the new leaf growth light green (Fig. 7B). The gall body is largely composed of whitish, expanded leaf bases, nodes, and expanded pith parenchyma (Fig. 7D, F). The gall is uniloculate (monothalmus) and characteristically contains a small, initially subspheroidal (Fig. 7C), later narrow, elongate-ellipsoidal, central open chamber within which the larva feeds (Fig. 7D). This gall is quite unlike the axillary bud galls of *A. ferruginea* and *A. michaeli,* both externally and internally (Goeden and Teerink 1996), and indeed, more closely resembles the galls of an apparently unnamed *Procecidochares,* misidentified as *P. stonei* Blanc and Foote (Tauber and Tauber 1968, Green et al. 1993), and certain Cecidomyiidae, all of which form fleshy, leafy, bud galls with narrow, elongate, cylindrical central cavities on *C. viscidiflorus* in southern California (Goeden and Teerink, unpublished data).

Eleven galls containing second instars averaged 12.0 ± 0.7 (range, 6.8–16.0) mm in length and 6.7 ± 0.3 (range, 6.0–9.0) in width (Fig. 7B, C). The gall cavities measured 5.0 ± 0.5 (range, 1.3–7.2) mm in length by 1.6 ± 0.1 (range, 0.8–2.3) mm in width (Fig. 7C). The inner surface of the chamber was shallowly pitted by larval feeding. The gall walls averaged 0.66 ± 0.06 (range, 0.28–0.93) mm in greatest thickness.

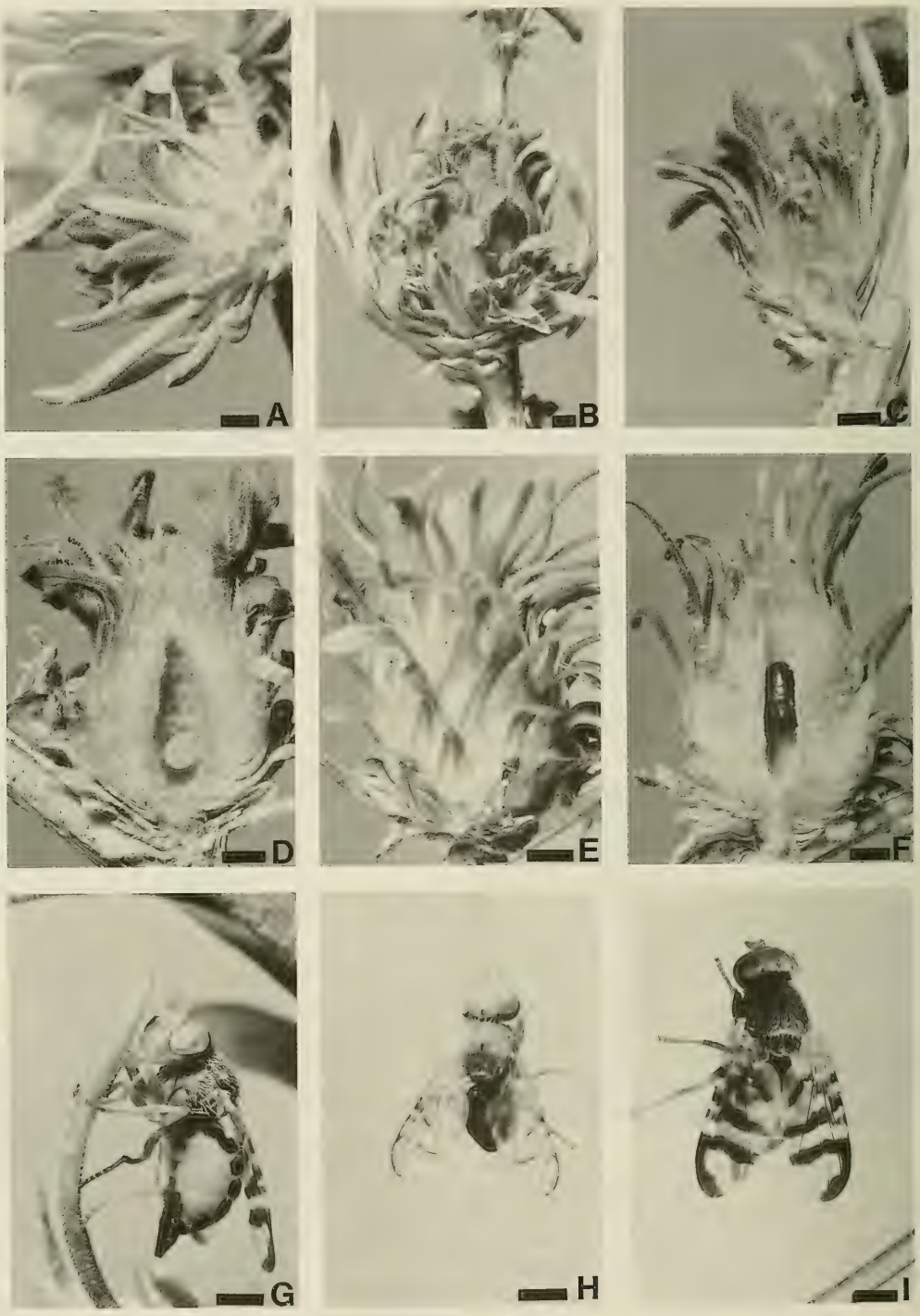

Fig. 7. Life stages of *Aciurina idahoensis* on *Chrysothamnus viscidiflorus* from California: (A) overwintered immature gall with dead leaves at base, (B) developing gall that contained a second instar, (C) saggital section of young gall with second instar in basal feeding chamber, (D) saggital section of gall containing early third instar, (E) full-size gall containing a puparium, (F) saggital section of gall containing puparium, (G) lateral view of newly emerged female, (H) dorsal view of male, (I) dorsal view of female. Line = 1 mm.

Nine galls containing third instars measured 12.1 ± 1.0 (range, 9.5–19.0) mm in length and 6.8 ± 0.4 (range, 4.6–8.6) mm in width (Fig. 7D, E). The elongated, ellipsoidal, central chamber averaged 6.2 ± 0.6 (range, 2.0–8.1) mm in length and 1.8 ± 0.2 (range, 0.8–2.5) mm in width (Fig. 7D); the surrounding gall wall was 1.10 ± 0.18 (range, 0.56–2.24) mm wide at its thickest point (Fig. 7C). The leaves adorning this gall laterally measured 10 mm long by 1 mm wide (Fig. 7E).

Pupa.—Prior to pupariation, the fully formed third instar eats through the apical end of the gall chamber and kills the apical bud and surrounding apical leaves, which turn brown, forming an exit channel for the adult. The puparium has its anterior end facing this exit channel (Fig. 7F). Twenty-two mature galls containing puparia measured 14.6 ± 0.4 (range, 11.0–20.0) mm in length and 8.8 ± 0.3 (range, 6.0–12.0) mm in width. The open central cavities, including the exit channel, measured 9.0 ± 0.3 (range, 6.2–11.0) mm in length and 2.1 ± 0.1 (range, 1.3–2.8) mm in width (Fig. 7F). The gall wall (Fig. 7F) measured 2.85 ± 0.11 (range, 1.68–3.64) mm at its widest. The leaves laterally adorning these galls measured 7–20 mm in length by 1–2 mm in width. This compares with mean gall lengths of 10.8 mm (range, 8.0–14.5 mm) and widths of 7.6 mm (range, 6.0–9.0 mm), and mean central cavity lengths of 8.0 mm (range, 4.5–12.0 mm) and widths of 2.0 mm (range, 1.5–3.0 mm) for 45 mature galls reported by Wangberg (1981). Apparently, galls of *A. idahoensis* tend to be slightly larger in California than in Idaho, if the samples compared are representative. Otherwise, no biologically significant differences in the galls were detected which would suggest separate species status for flies from these two States.

Adult.—The adult emerges from the apex of a gall by pushing aside the dead, basally excised bracts with its expanded ptilinum. Once the latter organ was free, one observed female emerged completely in a few seconds, and within about 5 minutes had fully expanded her wings (Fig. 7G). Newly emerged females contain many ova and their ovaries occupy and distend much of their abdomens (Fig. 7G). In the insectary, eight males lived 21 ± 8 (range, 13–38) days; two females, 14 and 22 days. Figures 7H and 7I further document the sexual dimorphic wing patterns of the male and female, respectively, in California.

Seasonal history.—Like *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996), *A. idahoensis* is univoltine on its shared, single host plant, *C. viscidiflorus,* in California. Together with *A. semilucida,* these four species partition *C. viscidiflorus* seasonally and altitudinally, with adults of *A. idahoensis* and *A. semilucida* emerging, mating, and ovipositing earlier in spring (May–June) at lower altitudes (<1800 m) than *A. ferruginea* and *A. michaeli,* which emerge, mate, and oviposit in summer (July–August) at higher elevations (>2100 m) (Goeden and Teerink 1996, unpublished data). Adults and galls of all four *Aciurina* spp. have not been found together, only paired as reported from separate locations in California (Goeden and Teerink 1996).

Natural enemies.—Wangberg (1981) reported the following Hymenoptera (Chalcidoidea) as associated with *A. idahoensis* (as "*Aciurina* sp. A") and its galls in Idaho: *Eurytoma chrysothamni* (Eurytomidae), solitary endoparasitoid; *Eupelmus* sp. (Eupelmidae), unknown relationship; *Torymus* sp. (Torymidae), ectoparasitoid?; *Halticoptera* sp. (Pteromalidae), solitary endoparasitoid; *Platygaster* sp. (Platygasteridae), unknown relationship. A single specimen of *Halticoptera* sp. was reared from a puparium as a primary, solitary endoparasitoid in our samples from California.

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REVIEW OF THE EASTERN UNITED STATES SPECIES OF THE LEAF-FOLDING SAWFLIES OF THE GENUS *PHYLLOCOLPA* BENSON (HYMENOPTERA: TENTHREDINIDAE)

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Abstract.—Larvae of *Phyllocolpa* live and feed in leaf folds of *Salix* and *Populus.* The eight species from eastern United States are described, including ***P. eleanorae,* n. sp.**, reared from leaf rolls on *Salix* in New York. A key is given for species identification, and biological observations are presented for *Phyllocolpa eleanorae, P. leavitti* (Rohwer), *P. nigrita* (Marlatt), and *P. terminalis* (Marlatt), all on *Salix.* Lectotypes are designated for *Pontania robusta* Marlatt and *P. terminalis* Marlatt.

Key Words: Leaf-folding sawflies, *Phyllocolpa,* willow, *Salix,* poplar, *Populus*

Phyllocolpa, a genus in the Nematinae, includes 25 or more species in North America. Smith (1979) cataloged 26 species, but the genus has not been studied, and the catalog is simply a list of described species without regard to possible synonymy or potential distribution. In recent years, the junior author has been involved in biological studies of several species on *Salix* in New York. Because of the taxonomic status of the genus and absence of keys, identification of the species was impossible. Study of the eastern species of *Phyllocolpa* was therefore necessary, and a review is presented here. Eight species are now known from eastern United States, four of which were studied by the junior author, and one of them is newly described.

Few morphological characters are apparent to separate *Phyllocolpa* from related genera. Females are separated by the acuminate sheath (in lateral view usually emarginate ventrally with acute or rounded apex, always shorter than the hindfemur, Figs. 15–20) and males by the short fourth hindtarsal segment (shorter dorsally than apically). In *Pontania* Costa and related genera, the female sheath is broadly rounded at its apex, not emarginate ventrally, and usually longer than the hindfemur, and the fourth hindtarsal segment of the male is at least as long dorsally as apically. Males are most difficult to separate from members of other genera and sex associations are not known for all species, thus they are not treated here. In part, *Phyllocolpa* is also separated by larval habits. The larvae feed and develop in rolled leaves or leaf folds on *Salix* and *Populus.* In related genera, *Nematus* Panzer larvae feed externally on foliage of various hosts, most *Pontania* larvae form closed pea-shaped or bean-shaped leaf galls on *Salix* and *Populus,* and *Euura* Newman larvae form stem, twig, petiole, or bud galls on *Salix.*

Species now in *Phyllocolpa* were first recognized as a distinct group by Marlatt (1896a) who placed them in his Group I of

the genus *Pontania.* Ross (1929) gave the most recent review of this group for North America and called them *Pontania,* Group I of Marlatt (1896a). Ross (1929) described several new species, mostly from western North America, and gave a key to 15 species. Benson (1960a) treated this group of species in *Pontania,* but separated them into his Section A and formed two species groups within this section, the *leucosticta* group and *leucapsis* group. The groups were separated by the dull and pilose or shining and glabrous antennal hollows, respectively. Benson (1960b) described the genus *Phyllocolpa* for these species. Smith (1979) listed the North American species, including those already transferred to this genus by Benson (1960b) and additional ones, which where wrongly placed in other genera. Since Benson's (1960b) description, *Phyllocolpa* has been regarded as a distinct genus.

More recently, Goulet (1992) restricted *Phyllocolpa* to those species with an acuminate sheath (as in Figs. 19, 20); other species with a more rounded sheath go to *Pontania* in his key. Only the species *P. leavitti* and *P. nigrita* treated here would belong in *Phyllocolpa*; the others in *Pontania.* Zinovjev (1993) treated *Phyllocolpa* as a subgenus of *Pontania.* The subgenus *Phyllocolpa* included those species with the sawsheath in lateral view distinctly emarginate beneath an acute apex (as in Goulet's interpretation), always shorter than the hindfemur, and larvae in rolled leaves (or leaf margins) without swelling at the site of egg laying. *Pontania* included species with the sawsheath round and only sometimes slightly emarginate beneath the apex and larvae in closed galls or leaf rolls with the site of egg laying marked by distinct swelling on the upper surface of the leaf. He divided the subgenus *Phyllocolpa* into two species groups, the *piliserra* group, which lacks cerci at the apex of the 10th tergum in the larvae and has up to 8 larvae in a single leaf roll, and the *leucapsis* group, which have cerci in the larvae and only a single larva in a leaf roll. He also included some leaf-rolling species in the *crassispina* group of the subgenus *Pontania.* Zinovjev's classification is based on adult and larval characters, as well as habits and type of leaf-roll or gall; therefore, knowledge of the adults, larvae, and habits is necessary to place species properly. Immatures and habits of North American forms are very poorly known. When adequate information is available, some of the species treated here may require placement in other genera. For now, we prefer treating all species in the traditional *Phyllocolpa* of Benson (1960b) and Smith (1979).

Seven species of *Phyllocolpa* have been described from eastern North America (Smith 1979). It is possible some of those described from the West are transcontinental, but a survey of them indicated that they are not. No host or biological data were included with the descriptions of these seven species, except for *Phyllocolpa populi,* and most of the subsequent biological information of this and other species is from the work of H. G. Dyar (1897a, b); therefore, association of four species with *Salix* and biological observations by the junior author are significant. All species were described from females. Because of the difficulty to discriminate among males and presence of more distinct characters in the females, only females are treated here.

Voucher specimens are deposited in the National Museum of Natural History, Washington, DC. Biological notes on *Phyllocolpa eleanorae, P. leavitti, P. nigrita,* and *P. terminalis* are those of the junior author.

Key to Eastern United States Species of *Phyllocolpa*

1. Predominately orange, with black markings on dorsum of head, spots or streaks on mesonotum, and dorsum of abdomen (Figs. 1, 2, 8, 9) (apex of sheath rounded, Fig. 15) 2
– Predominately black, with pale-orange or yellowish areas mostly confined to orbits, supraclypeal area, pronotum, venter of abdomen,

and possibly spot or stripe on mesopleuron (Figs. 3–7, 10–14) 4

2. Antennal hollows glabrous and shining (Fig. 8); mesonotum with central black area covering posterior part of mesoprescutum and lateral areas of lateral lobes (ventral surface of mesothorax orange; on *Populus*) . . *robusta* (Marlatt)
– Antennal hollows dull and pilose (Fig. 9); mesonotum with three black spots or stripes, one on mesoprescutum and one on each lateral lobe 3
3. Ventral surface of mesoshorax orange as rest of underthorax; postocellar area black; postocellar area about 2.5× broader than long (Fig. 2) . . . . . *acuminata* (Marlatt)
– Ventral surface of mesothorax black; postocellar area orange (black only around and between ocelli); postocellar area about 3.0× broader than long . . . . . *pectoralis* (Marlatt)
4. Sheath in lateral view bluntly rounded at apex (Figs. 16–18) 5
– Sheath in lateral view acute at apex (Figs. 19–20) 7
5. Antennal hollows shining and not pilose; orbits broadly and supraclypeal area pale orange (Figs. 3, 10) (on *Salix*; mesopleuron possibly with central orange spot or stripe; pronotum mostly whitish except anterior margin) . . . . . *eleanorae*, n. sp.
– Antennal hollows dull and pilose; orbits, except possibly for spot on upper side, and supraclypeal area black (Figs. 4, 5, 11, 12) 6
6. Abdomen black; pronotum mostly black except for whitish posterior margin; on *Salix* . . . . . *terminalis* (Marlatt)
– Abdomen yellow ventrally; pronotum mostly pale orange to whitish except for anterior margin; on *Populus* . . . . . *populi* (Marlatt)
7. Abdomen black; orbits broadly orange (Figs. 6, 13); sheath straight above (Fig. 19); postocellar area short, nearly 3.0× broader than long (Figs. 6) . . . . . *nigrita* (Marlatt)
– Abdomen orange ventrally; orbits narrowly orange (Figs. 7, 14); sheath slightly emarginate above (Fig. 20); postocellar area longer, about 2.2× broader than long (Fig. 7) . . . . . *leavitti* (Rohwer)

Phyllocolpa acuminata (Marlatt)
(Figs. 2, 9)

Pontania acuminata Marlatt 1896a: 32. "One female. Michigan".—Benson 1960a: 380 (*leucosticta* group).

Phyllocolpa acuminata: Burks 1967: 22.—Smith 1979: 74.

Female.—Length, 5.0 mm. Antenna with scape and pedicel black (flagellum missing). Head orange with postocellar area black. Thorax orange with following black: spots on mesoprescutum and each mesonotal lateral lobe; posterior margin of mesoscutellum; posttergite; metanotum; mesepimeron; and metapleuron. Abdomen black dorsally, orange laterally and ventrally. Legs orange with hindtarsus and hindtibia blackish. Forewing with stigma and veins dark brown. Antennal hollows dull, finely punctate and pilose. Postocellar area 2.5× broader than long. Sheath in lateral view with narrowly rounded apex and slightly emarginate ventrally (as in Fig. 15).

Holotype.—U.S.N.M. type no. 1972, ♀, labeled "Ag. Coll. Mich. [= East Lansing], 5-20 '92, 168" and with Marlatt's determination label.

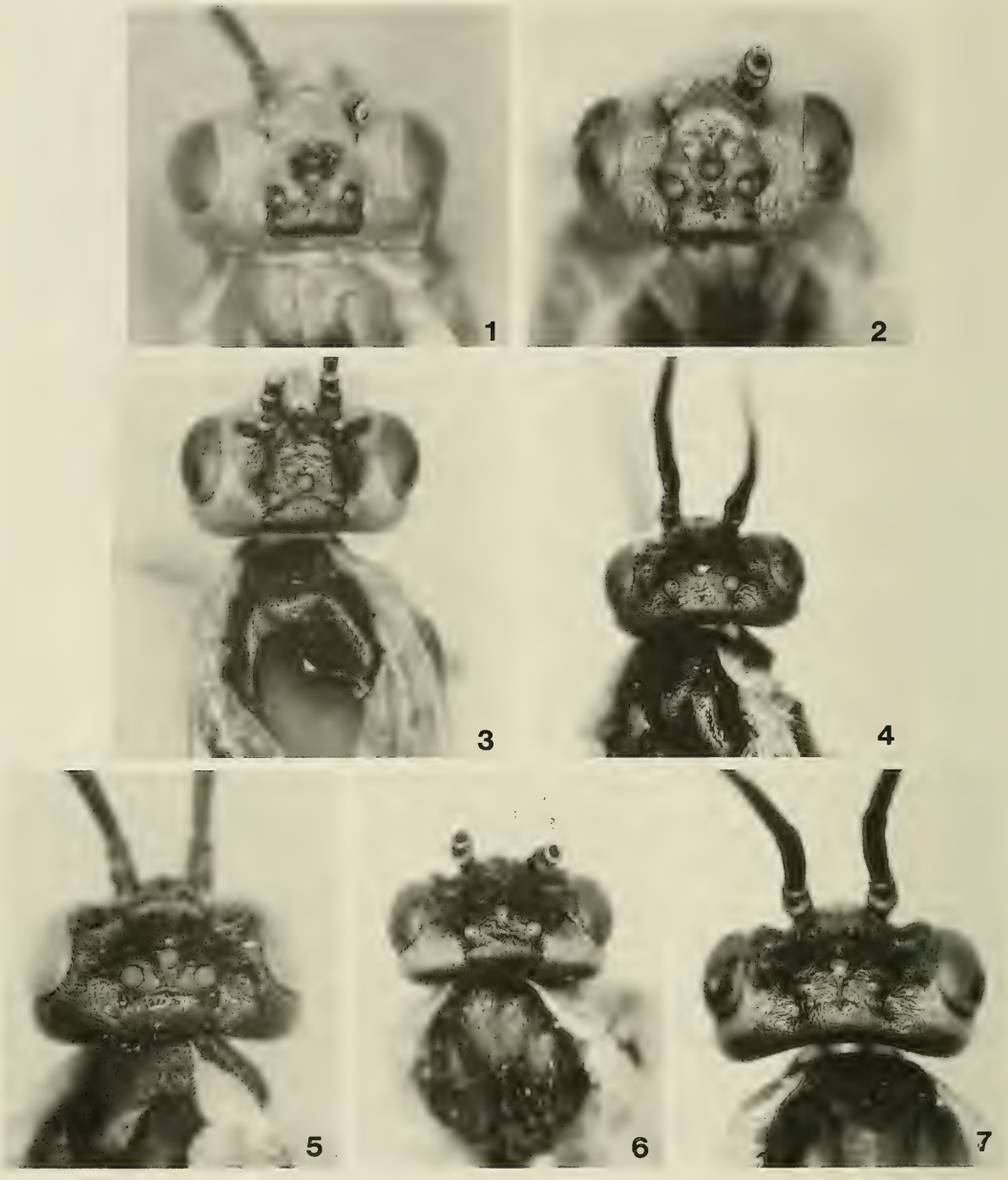
Distribution.—Michigan.

Host.—Unknown.

Discussion.—We saw only the holotype. The dull, pilose antennal hollows, longer postocellar area, and color as given in the key will separate *P. acuminata* from the other mostly orange species, *P. robusta* and *P. pectoralis*.

Phyllocolpa eleanorae Smith and Fritz, new species
(Figs. 3, 10, 16, 21)

Female.—Length, 4.3 mm. Antenna black above, pale orange below. Head black on dorsum and to antennae and with small black spot in tentorial pits; inner and outer orbits and supraclypeal area mostly orange, clypeus and mouthparts whitish. Thorax black with pronotum whitish and with tegula and sometimes faint spot on mesopleuron pale orange. Abdomen black dorsally, pale orange ventrally. Legs orange with basal half of hindcoxa black; hindtarsus slightly darker than femur and tibia. Forewing with costa, subcosta, and stigma pale amber, veins brownish. Antennal hollows shining and glabrous. Postocellar area short, slightly more than 3× broader than long. Mesopleuron shiny, without sculpture.



Figs. 1–7. Dorsal view of head and anterior thorax. 1, *Phyllocolpa robusta.* 2, *P. acuminata.* 3, *P. eleanorae.* 4, *P. terminalis.* 5, *P. populi.* 6, *P. nigrita.* 7, *P. leavitti.*

Sheath in lateral view narrowly rounded at apex, emarginate ventrally (Fig. 16).

Holotype.—♀, labeled "New York, Otsego [Co.], Milford, June 1989, *Salix sericea,* col. R. Fritz." In the National Museum of Natural History, Washington, DC.

Paratype.—NEW YORK: Same data as holotype (1 ♀). Deposited with the holotype.

Other specimens.—We examined about 25 additional specimens without host data from Maine, Michigan, New York, and Vermont but prefer to use only the reared specimens for the type series.

Hosts.—*Salix sericea* Marsh., *S. eriocephala* Michx., *S. discolor* Muhl.

Etymology.—Named for Eleanor Sosnowski who kindly allowed use of property for field studies by the junior author.

Discussion.—The bluntly rounded apex of the sheath, shining and glabrous antennal hollows, and coloration as given in the key will distinguish *P. eleanorae* from other mostly black *Phyllocolpa* species.

Biology.—*Phyllocolpa eleanorae* oviposits near the middle of the leaf fold (Fig. 21a) on the three willow species on which it oviposits (*Salix sericea, S. eriocephala,* and *S. discolor*). We have reared *Phyllocolpa eleanorae* only from *Salix sericea,* but we assume, based on similarity of the leaf folds, that it is the same species on *S. discolor* and *S. eriocephala.* On *Salix sericea,* the median egg location is at about 45% of the length of the leaf fold. On *Salix eriocephala* the median egg location is over 60% of the leaf fold length, but on *S. discolor* the median egg location is about 30% of the leaf fold length (Fritz and Kaufman 1993). On each of the willow species there is considerable variance in the location of the egg, and it may even be located in the same relative location as the eggs of *Phyllocolpa nigrita* (see below and Fig. 21c). A characteristic of the leaf folds of *Phyllocolpa eleanorae* that is useful in distinguishing them from *P. nigrita* is that the proximal edge of the fold is tightly curled over. *Phyllocolpa nigrita* folds flare out at the base near where the egg is located.

The last larval instar of *Phyllocolpa eleanorae* frequently consumes the tip of the leaf before dropping to the ground to pupate. A species of *Trichogramma* Westwood (Hymenoptera: Trichogrammatidae) is a major source of egg mortality for *Phyllocolpa eleanorae,* and mortality varies among the three willow species that have been studied (Fritz and Kaufman 1993).

Phyllocolpa leavitti (Rohwer)
(Figs. 7, 14, 20–22)

Pontania leavitti Rohwer 1910: 199. "Nerepis, New Brunswick. One female collected July 11 by A. G. Leavitt".—Ross 1929: 96 (*leaviti* [!]; in key).—Benson 1960a: 380 (*leucapsis* group).

Phyllocolpa leavitti: Burks 1967: 22.—Smith 1979: 75.

Female.—Length, 5.0–5.2 mm. Antenna and head black; eye orbits narrowly, supraclypeal area, clypeus, and mouthparts pale orange to whitish. Thorax black with posterior margin of pronotum and tegula pale orange. Abdomen black with venter pale orange. Legs pale orange. Antennal hollows dull and pilose. Postocellar area about 2× broader than long. Mesopleuron shiny, with only faint microsculpture. Sheath in lateral view acute at apex, upper margin very slightly concave, apicoventral margin concave (Fig. 20).

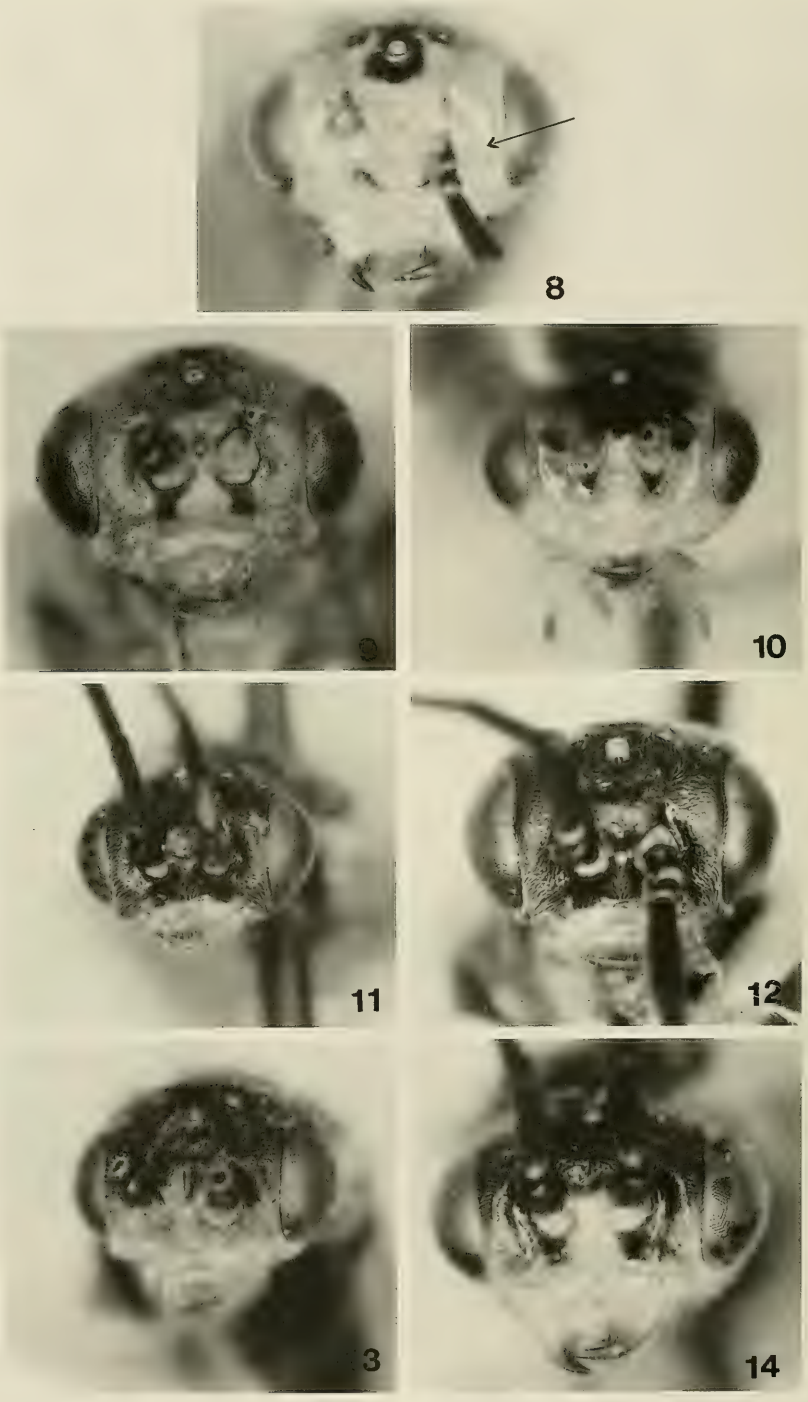
Holotype.—U.S.N.M. type no. 12921, ♀, labeled "Nerepis, NB, 11 Jul, AGLeavitt, Collector."

Distribution.—New Brunswick: Nerepis (holotype). New York: Otsego Co., Milford, June 1989, *Salix sericea,* R. Fritz; spiral Phyl., LS field, 6-20-89, R. Fritz. About 40 additional specimens from Maine, New Hampshire, New York, Quebec, and Vermont

Host.—*Salix sericea.*

Discussion.—The acute apex and emarginate ventral surface of the sheath places *Phyllocolpa leavitti* close to *P. nigrita,* but in *P. leavitti* the sheath is slightly emarginate above. Color differences are given in the key.

Biology.—A single specimen was reared from collections on *Salix sericea.* The leaf folds (Fig. 22) are similar to those of *Phyllocolpa terminalis* (Fig. 23) but appear to be distinguishable by the less smooth surface of the rolled leaf, which may be due to hypertrophication of the leaf blade where stung by the female sawfly. The leaf blade is not rolled as many times as in *Phyllocolpa terminalis,* only 0.5–1.5 times, and the egg is laid near the midvein, rather than near the edge of the blade (Fig. 21b).



Figs 8–14. Front view of head. 8, *Phyllocolpa robusta* (arrow indicates antennal hollow). 9, *P. acuminata.* 10, *P. eleanorae.* 11, *P. terminalis.* 12, *P. populi.* 13, *P. nigrita.* 14, *P. leavitti.*

Phyllocolpa nigrita (Marlatt)
(Figs. 6, 13, 19, 21)

Pontania nigrita Marlatt 1896a: 27. "One female. Michigan".—Ross 1929: 97 (in key).
Pontania pallicornis: Dyar 1897b: 196.
Phyllocolpa nigrita: Smith 1979: 75.
Phyllocolpa sp.: Smith 1987: 382 (Dyar's "71").

Female.—Length, 4.0–4.5 mm. Antenna mostly black, somewhat paler underneath. Head black; eye orbits broadly, supraclypeal area, malar area, clypeus and mouthparts pale orange. Thorax black with most of pronotum and tegula pale orange. Abdomen black. Legs pale orange with basal half of hindcoxa black. Antennal hollows dull, finely punctate and pilose. Postocellar area short, about 3× broader than long. Mesopleuron shiny, without sculpture. Sheath in lateral view with acute apex, slightly emarginate ventrally, straight dorsally (Fig. 19).

Holotype.—U.S.N.M. type no. 1909, ♀, labeled "Ag. Coll. Mich. [= East Lansing], 5-21-91, Ac. 190 Sp."

Distribution.—Michigan (holotype). New York: Van Cortlandt Park (H. G. Dyar); Otsego Co., Milford, *Salix sericea,* July 26, 1988, June 1989, R. Fritz (about 35 specimens). About 20 additional specimens from Michigan, New Hampshire, New York, and Virginia.

Host.—*Salix sericea, S. discolor, S. eriocephala.*

Discussion.—This species is close to *Phyllocolpa leavitti*; see key and notes under this species for separation.

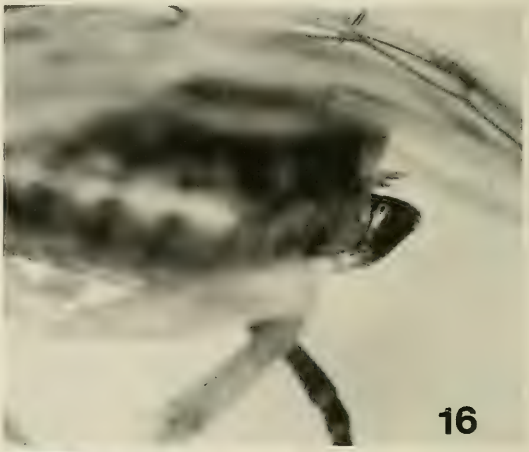
Biology.—One of Dyar's specimens labeled "71", was identified and described under the name *Pontania pallicornis* Norton (Dyar, 1897b, Smith, 1987). Dyar gave the following notes: "With the habits of *P. robusta* but living on the willow. The smooth leaves are closely folded over, the house long on the narrow leaf, 25 to 40 mm., about one-fourth of the leaf turned over, so that the outer edge just reaches the midrib. The folded part at the angle where it is bent is slightly swollen and yellowish, caused by little scattered patches eaten from the under side." "The larva comes out the apex of the house and eats the whole leaf. Single brooded; the larvae can be found till the middle of June. (Cocoons formed on the ground.) On the willow at Van Cortlandt Park, N.Y."

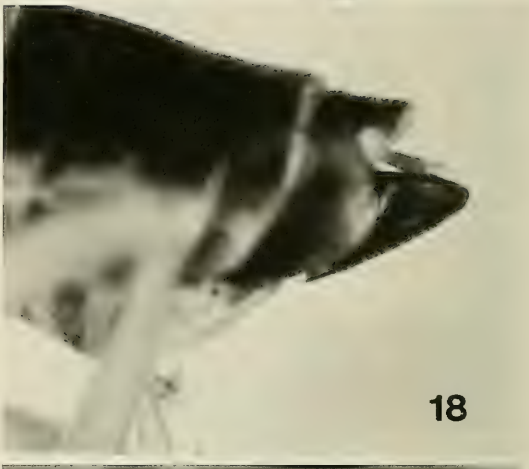
On both *Salix sericea* and *S. eriocephala,* the location of the oviposited egg is near the base of the leaf fold (Fig. 21c) (median egg position is 5% of the fold length) and there is less variation in egg location than for *Phyllocolpa eleanorae* (Fritz and Kaufman, 1993). On *Salix discolor* the median egg location is over 10% and there is more variation than on *S. eriocephala* and *S. sericea.* Egg mortality due to *Trichogramma* sp. is higher on *Phyllocolpa nigrita* than on *P. eleanorae.* This may be due to the increased exposure of the egg where the folded over leaf edge of the fold flares out (Fritz and Kaufman, 1993).

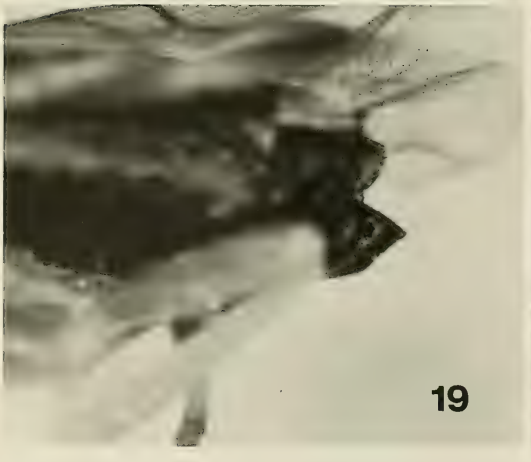
Phyllocolpa pectoralis (Marlatt)

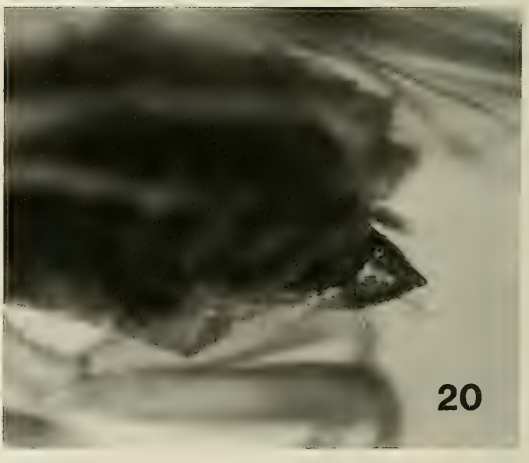
Pontania pectoralis Marlatt, 1896a: 31. "One female. Algonquin, Ill."
Phyllocolpa pectoralis: Burks 1967: 22.—Smith 1979: 75.

Female.—Length, 5.0 mm. Antenna black, paler on undersurface and toward apex, especially apical 3–4 segments. Head orange with black only around and between hindocelli and spot anterior to front ocellus extending about half way to antennal insertions. Thorax orange with following black: cervical sclerites except small spot anteriorly; spots on mesoprescutum and each mesonotal lateral lobe; posterior margin of scutellum; posttergite; metanotum; ventral surface of mesothorax; lower half of mesepimeron; and metapleuron. Abdomen black dorsally and orange ventrally; basal 6 terga entirely black, remaining terga orange laterally; apical segment orange; terga with narrow, white posterior borders; sheath blackish dorsally, bottom half to two-thirds









Figs. 15–20. Lateral vew of apex of abdomen and sheath. 15, *Phyllocolpa robusta.* 16, *P. eleanorae.* 17, *P. terminalis.* 18, *P. populi.* 19, *P. nigrita.* 20, *P. leavitti.*

orange. Legs orange, basal half of hindcoxa black. Forewing with costa and stigma amber, apical half of stigma slightly more brownish; veins brownish. Antennal hollow somewhat shining but with fine punctures and pilose between hollows and eyes. Postocellar area little more than 2× broader than long. Sheath in lateral view narrowly rounded at apex, slightly concave ventrally (as in Fig. 15).

Holotype.—At Cornell University (Hoebeke 1980), ♀ labeled "Algonquin, Ill.," "4425," "Pontania pectoralis Marlatt, type," "Cornell U. Lot 187, sub. 51a," "Type Cornell U. No. 4522."

Distribution.—Illinois.

Host.—Unknown.

Discussion.—We have seen only the holotype. The species is separated from other orange species by the dull and pilose antennal hollows, mesonotum with three black spots, black ventral surface of the mesothorax, orange postocellar area, and the postocellar area about three times broader than long.

Phyllocolpa populi (Marlatt)
(Figs. 5, 12, 18)

Pontania populi Marlatt, 1896b: 253. "Described from a single female, reared by H. G. Dyar, from larva collected in New York." ". . . on *Populus grandidentata*".—Dyar 1897a: 24.—Benson 1960a: 380 (*leucosticta* group).

Phyllocolpa populi: Burks 1967: 22.—Smith 1979: 75.—Smith 1987: 382.

Female.—Length, 4.8–5.4 mm. Antenna and head black; light orange spot on upper inner orbit. Thorax black with most of pronotum and tegula pale orange. Abdomen black dorsally, pale orange ventrally. Legs pale orange with base of hindcoxa black and hindtarsus darker than femur and tibia. Forewing with stigma and veins light brown. Antennal hollows dull and pilose. Postocellar area about 2.3× broader than long. Mesopleuron shiny, without sculpture. Sheath in lateral view pointed at apex, not distinctly emarginate ventrally (Fig. 18).

Holotype.—U.S.N.M. type no. 3474, ♀, labeled "7H", "N.Y. Coll. H.G. Dyar" "reared from larva on Populus grandidentata." This specimen bears the type label and Marlatt's determination label, and is presumably the only specimen Marlatt examined. There are four other females in the collection from Dyar's "7H" rearings.

Distribution.—We examined about 55 specimens from Connecticut, Maryland, Massachusetts, New Jersey, New York, Ontario.

Host—*Populus grandidentata* Michx.

Discussion.—This species and *Phyllocolpa robusta* are the only species with larvae feeding on poplar. The coloration and sheath shape as given in the key and as described and illustrated will distinguish this species. The sheath is not emarginate ventrally as in most other *Phyllocolpa* species.

Biology.—Dyar's 7H code refers to specimens from Fort Lee, N.J. (Smith 1987). Dyar (1897a) described the larva and gave the following notes: ". . . forms at first a small gall, but soon the leaf rolls over, gall and all, forming two or three turns and the larva lives in the tube so formed, without spinning any sort of web." "The larva remains in the gall up to as late as the fourth stage, but is usually out to feed in the third. It may be in the rolled part permanently in stage IV." "The larvae never eat the whole leaf, but the parenchyma only, even in the last stage. They spin small brown cocoons." "Found on *Populus grandidentata* at Fort Lee, N.J. There is more than one brood in the season, the larvae infesting the successive leaves of young shoots."

Several specimens were reared from *Populus grandidentata* at East River, Connecticut. They are under Hopkins' No. 10746b, and notes associated with this are as follows: "Sawfly larvae feeding on young leaves of *Populus grandidentata.* The larvae roll the edge of the leaf and feed within the roll. In most cases the rolling of the leaf appears to be caused in the first

place by a gall and as no very young larvae were found in the rolls it is thought possible that the earliest stage or stages may be passed within the gall." Larvae were collected July 7 to 15, 1915. By July 23 most larvae had cocooned. Several adults emerged July 24 and August 6, 1915.

Other specimens from Massachusetts, New Jersey, Connecticut, and Ontario bear host labels either as *Populus* sp. or *Populus grandidentata.*

Phyllocolpa robusta (Marlatt)
(Figs. 1, 8, 15)

Pontania robusta Marlatt 1896a: 32. "One female and one male. Michigan and District of Columbia (?)".—Dyar 1897b: 195.—Benson 1960a: 381 (*leucapsis* group).

Phyllocolpa robusta: Burks 1967: 22.—Smith 1979: 75.—Smith 1987: 381.

Female.—Length, 5.0 mm. Antenna with scape, pedicel and first flagellar segment black above, orange underneath (rest of flagellum missing). Head orange with postocellar area and circle around front ocellus black. Thorax orange with following black: central spot on mesonotum covering apex of mesoscutellum and medial portion of each lateral lobe; narrow longitudinal median stripe on mesoscutellum, posterior margin of mesoscutellum, and posttergite; and metanotum. Abdomen black dorsally, orange laterally and ventrally; apex of sheath black. Legs orange. Forewing with costa, subcosta, and stigma pale amber, veins brownish. Antennal hollows shiny and glabrous. Postocellar area short, about 3× broader than long. Mesopleuron shiny. Sheath in lateral view narrowly rounded at apex, emarginate ventrally (Fig. 15).

Male.—Length, 4.7 mm. Similar to female except thorax black with broad orange steak on mesopleuron, pronotum mostly orange, and legs orange with basal third of hindcoxa black.

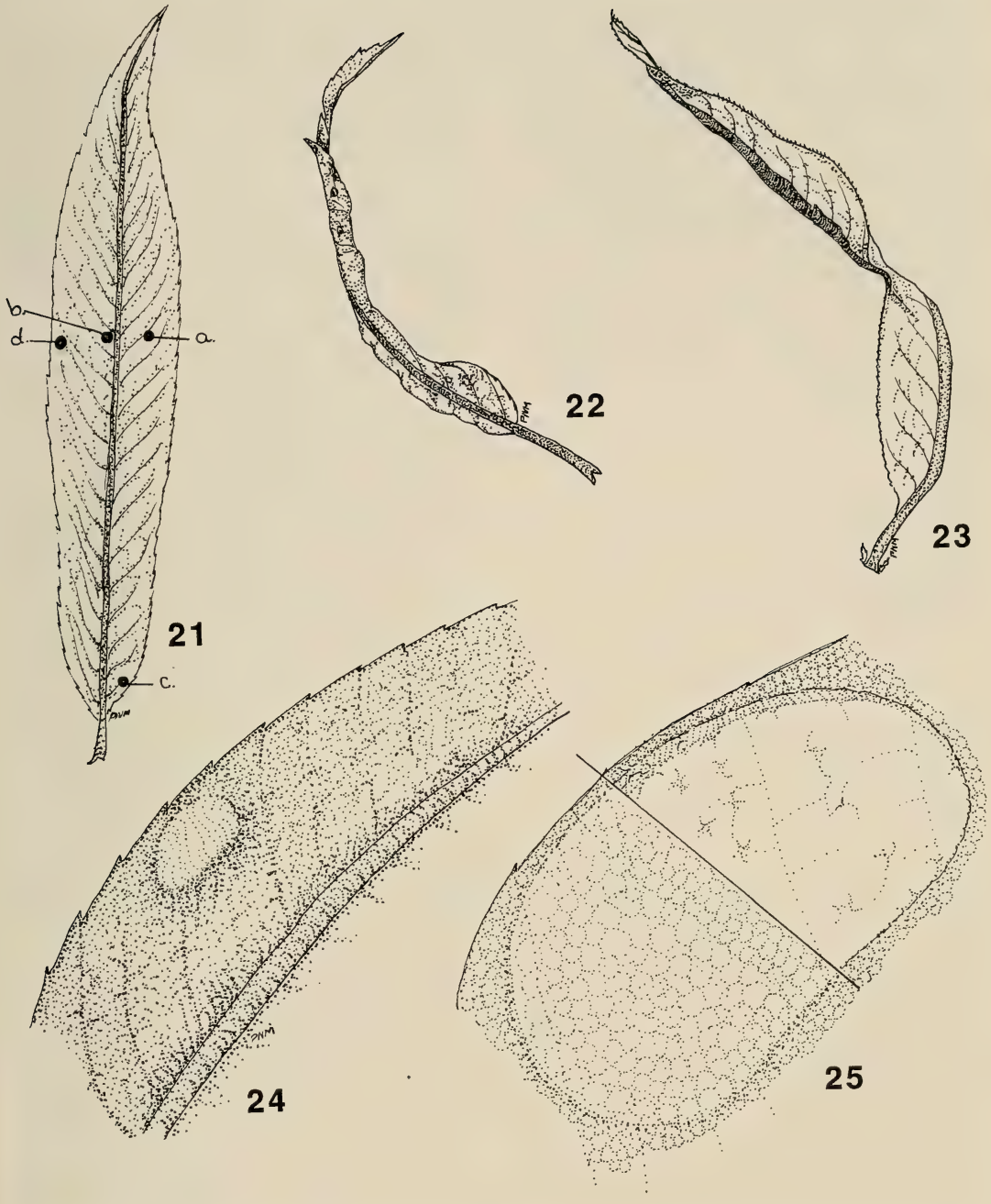
Lectotype.—By present designation, the lectotype is the female described by Marlatt, and labeled "Ag. Coll. Mich. [= East Lansing], 5-30-92, 193" "Type No. 1913, U.S.N.M." and with Marlatt's determination label. The male from the District of Columbia (?) is labeled "Collection C.V. Riley." It is not *P. robusta,* and we doubt that it is from the District of Columbia; therefore, we are not considering it a paralectotype.

Distribution—Michigan (lectotype), New Jersey (3 specimens reared by H. G. Dyar).

Host.—*Populus tremuloides* Michx.

Discussion.—The predominately orange coloration and glabrous and shining antennal hollows separate *Phyllocolpa robusta* from other mostly orange *Phyllocolpa* species.

Biology.—Dyar reared this species under his code "7F" (Smith, 1987); two females and one male are from his rearings. The females compare favorably with Marlatt's type female except for a larger black spot on the ocellar area, but the male associated is clearly different than that described by Marlatt from the specimen from the District of Columbia(?). Dyar's association by rearing precludes Marlatt's male from being the male of *P. robusta.* Dyar (1897b) gave the following notes: "No gall, but a portion of the leaf simply folded over. The egg is deposited under the lower epidermis near the edge, not far from the petiole. The larva eats little patches of the parenchyma on the under side scattering three-fourths of the way to the apex, apparently while the leaf is young; these patches are slightly swollen, discolored, pale, and as a result the outer fourth of the leaf folds back, nearly touching the surface, forming a hollow in which the larva lives. Finally the larva eats the whole leaf, emerging from its house and eating the apex of the leaf to return to the house again after feeding. The leaf is not rolled at all, simply folded. Fresh eggs were found May 9th. At that time the young leaf was nearly folded back though not fully grown. On expanding the folded part it was seen to be slightly larger than normal, forming a lobe on the leaf. The egg was situated



Figs. 21–25. 21, Willow leaf outline with oviposition sites for a) *Phyllocolpa eleanorae,* b) *P. leavitti,* c) *P. nigrita,* and d) *P. terminalis.* 22, Leaf fold of *P. leavitti*; note that midvein forms a spiral and the surface of the leaf fold is not smooth. 23, Leaf fold of *P. terminalis*; the midvein forms a spiral, but the leaf surface is usually smooth. 24, Depiction of the small gall of *Phyllocolpa terminalis* that forms on the upper leaf surface of the willow leaf before the leaf blade rolls tightly. 25, Appearance of the under leaf surface of the mined gall of *P. terminalis* with the epidermis intact (left) and with the epidermis removed (right). The inside of the mined gall reveals large, light green cells of hypertrophied mesophyll.

under the lower epidermis, elliptical, white, .4 × .8 mm." "The larva eats the whole leaf when it emerges, sitting on the edge, the body curled down a little on one side of the leaf. The larvae will rasp with their prongs in the houses if disturbed. At the end of the stage the larvae enter the ground." "Found on the small leaved poplar (*Populus tremuloides*) at Fort Lee, N.J. I have also seen the characteristic houses on the poplar near New York City and at Jefferson, NH. There is only one brood a year, the larvae disappearing at the end of May or a little later. The houses remain on the tree much longer. Cocoons formed on the ground."

Phyllocolpa terminalis (Marlatt)
(Figs. 4, 11, 17, 21, 23–25)

Pontania terminalis Marlatt, 1896b: 253. "Described from three females and two males reared by H. G. Dyar, from imperfect galls in the partly-rolled terminals of willow leaves. Specimens collected near New York City".—Dyar 1897a: 24.—Benson 1960a: 380 (*leucosticta* group).
Phyllocolpa terminalis: Burks 1967: 23.—Smith 1979: 75.—Smith 1987: 382.

Female.—Length, 4.7–5.0 mm. Antenna black. Head black with upper outer and/or inner orbits sometimes narrowly brownish; clypeus and mouthparts whitish. Thorax black with pronotum and tegula pale orange. Abdomen black. Legs pale orange with basal half of hindcoxa black. Forewing with veins and stigma light brown. Antennal hollows dull and pilose. Postocellar area short, about 3× broader than long. Mesopleuron shiny, without sculpture. Sheath in lateral view with narrowly rounded apex, straight dorsally, slightly emarginate ventrally (Fig. 17).

Lectotype.—Here designated, a female labeled "7K" "N.Y., H.G. Dyar" "Type No. 3473 U.S.N.M." and with Marlatt's determination label. A male is also labeled as type by Marlatt. Four other specimens (3 F and 1 M) are also in the collection, all from the same rearings labeled "7K." The male and two of the females must be part of the type series. Two males and two females labeled "7K" are designated paralectotypes.

Distribution.—New York: New York City (lectotype and paralectotypes, reared by H. G. Dyar); Otsego Co., Milford, *Salix sericea,* June 1989, June 1990, R. Fritz (5 specimens). About 15 additional specimens from New Hampshire, New York, and Vermont.

Host.—*Salix sericea.*

Discussion.—The sheath is similiar to that of *Phyllocolpa populi,* but the pronotum is mostly black, the abdomen is black, and the larvae feed on *Salix,* not *Populus.*

Biology.—Dyar's "7K" rearings were from Van Cortlandt Park, New York City (Smith, 1987). Dyar (1897a) described the larva and gave the following notes: "Egg deposited under the lower epidermis forming a small gall-like swelling. . . . A green elevation of the upper surface; below a thin skin, not swollen, but slightly yellowish; the leaf rolls over tightly in a close coil to two whole turns, finally as far as the midrib, from one half to the whole of one side of the leaf being involved. The little larva lives in the gall, but soon comes out of it and rests in the rolled part." "Found on willow at Van Cortlandt Park, New York City."

Our observations of the galls of *Phyllocolpa terminalis* coincide closely with those of Dyar. Eggs are oviposited near the middle of the leaf (Fig. 21d), and, after a few days, a small gall is formed (Figs. 24). When the egg hatches, the larva lives inside the leaf tissue of the gall mining a portion of the gall (Fig. 25) before emerging into the tightly rolled leaf fold (Fig. 23). The leaf edge is rolled over from 1.0 to 3.5 times, and the rolled edge can extend across the midvein. Sometimes the opposite leaf edge is also rolled from 0.5 to 3.0 times, but there is no egg oviposited and often soiling of the opposite edge does not occur. We presume that the female sawfly causes both of the leaf edges to curl over due to

stinging both sides of the leaf blade. As a result of the curled-over leaf edge, the midvein of the leaf forms a a loose spiral form. The surface of the leaf fold is distinctly smoother than the leaf folds of *P. eleanorae, P. nigrita,* and *P. leavitti.*

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AN ANNOTATED LIST OF NORTH AMERICAN BLASTOBASINAE (LEPIDOPTERA: GELECHIOIDEA: COLEOPHORIDAE)

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Abstract.—An annotated list of the North American Blastobasinae (Lepidoptera: Gelechioidea: Coleophoridae) is based upon the examination of type specimens of all available names. In addition, an abridged list is included to facilitate taxonomic reference. Lectotypes are designated for 52 species. Sixty-one **new synonymies** are proposed; including *Blastobasis modestella* (Clemens, 1863), a suppressed senior synonym of *B. glandulella* (Riley, 1871), pending ruling on application for suppression submitted to ICZN. Four species are elevated from varietal status to full species status, one species is of revised status, and one species is of new status. *Blastobasis segnella* Zeller, 1873 is omitted from the list because it does not occur in America North of Mexico.

Key Words: Lepidoptera, Coleophoridae, check list

The Blastobasinae are small to medium-sized, narrow-winged moths. Approximately 200 species are known worldwide. This number, however, greatly underestimates the species richness of the group because many undescribed species, especially from the Neotropics, are represented in museum collections. The blastobasine moths are probably one of the most commonly collected groups of Gelechioidea in the Americas. Yet this subfamily may be one of the least known to science. Generally, species are drab with few, if any, diagnostic wing color patterns, making identifications difficult unless the genitalia are examined.

Since Meyrick (1894) the Blastobasinae have been considered to be a monophyletic group. Recent studies (Adamski and Brown 1989, Hodges, in press) have corroborated this notion and have rigorously established the monophyletic relationships among the genera and the phylogenetic relationships of Blastobasinae within Gelechioidea. Our list follows the current phylogenetic classification of the Gelechioidea proposed by Hodges (in press). In this work the Blastobasidae (*sensu* Adamski and Brown 1989) are treated as a subfamily within the Coleophoridae. Consequently, all higher category names proposed by Adamski and Brown (1989) are reduced in level within this list.

Materials and Methods

All type specimens were obtained by loan or examined and dissected at the following institutions: ANSP—Academy of Natural Sciences of Philadelphia, Pennsylvania, USA; BMNH—The Natural History Museum, London (formerly, British Museum of Natural History), England; CNC—Canadian National Collection, Agriculture Canada, Ottawa, Canada; MCZ—Museum of Comparative Zoology, Harvard University Cambridge, Massachusetts, USA; UCB—University of California, Berkeley, California, USA; USNM—National Muse-

um of Natural History, Smithsonian Institution, Washington, D.C., USA.

Approximately 450 permanent slide mounts of male and female genitalia were prepared following the method of Clarke (1941). Genital slide mounts of material examined at The Natural History Museum, London were prepared following Robinson (1976). Both methods of dissection were modified by using mercurochrome and chlorazol black as separate staining procedures and by mounting the aedeagus *in situ* to enable accurate interpretation of the anellus and associated structures. Within our list, label data taken verbatim are expressed within quotations, while bracketed data are used to complete label data written in abbreviated form, or to help with the recognition of certain labels by description of condition, e.g., [red label]. Specimen data for some species include Hopkins numbers, a record-keeping system used by the United States Forest Service to verify the association of reared specimens with their hosts, damage, and other information.

Annotated List

BLASTOBASINAE, Meyrick, 1894:22

HOLCOCERINI Adamski, *in* Adamski and Brown 1989:16, **new status**

ASAPHOCRITA Meyrick 1931:78

HOLCOCERINA McDunnough 1961:14

aphidiella (Walsingham 1907a:205), *Holcocera,* **n. comb.**

Holotype ♂. "Pupa in gall of *Phylloxera* on Hickory [*Carya* sp.], Oct[ober]/[18]82"; "3689, Wlsm, 1889"; "31. Unique; not named in Europe, 1884, 1886" [hand-written label]; "*Blastobasis aphidiella* Riley MS, ♂" [hand-written label]; "*Holcocera aphidiella* Wals., Type"; "USNM Type No. 10676" [red label]; "USNM ♂ genitalia slide 80993, DA 2423" [green label]. The holotype has the left pair of wings and the right forewing mounted on a rectangular card beneath the specimen, [USNM]. Eight specimens in the MCZ (each bearing a red cotype label) represent a series of the manuscript name "*H*[*olcocera*] *cardinella* Dietz." One specimen bears a hand-written determination label. These specimens are conspecific with *A. aphidiella.*

dives (Dietz 1910:26), *Holcocera,* **n. syn.**

Lectotype here designated: ♂, "Hazleton, P[ennsylvani]a. [Charleroi, Pa.], El[ectric] l[igh]t, 6[June]/13/[18]89"; "cotype" [red label]; "USNM ♂ genitalia slide 81002, DA 2432" [green label], [USNM].

Paralectotypes 1 ♂, 5 ♀. (1) "5[May]/[19]07"; "Cohasset Mass[achusetts]"; "Owen Bryant collector"; [specimen not dissected]. 1 ♀, USNM. (2) "Plummer's [sic] I[sland], M[arylan]d, July 1903"; "Aug[ust] Busck collector"; "cotype" [red label]; "*H*[*olcocera*] *dives* Dietz" [hand-written label]; "USNM ♀ genitalia slide 81001, DA 2431" [green label]. 1 ♀, [USNM]. (3) "6[June]/5/[18]95" [hand-written label, in red ink]; "Dr. Dietz, Hazleton, Penn[sylvani]a"; "cotype" [red label]; "USNM ♀ genitalia slide 81003, DA 2433" [green label]. 1 ♀, [USNM]. (4) "Hazleton P[ennsylvani]a, 6[June]/3/[19]03, *Pinus*"; "cotype" [red label]; "WG Dietz, Coll[ection]"; "D Adamski ♀ genitalia slide 2083" [green label]; "Type 2951" [red label]. 1 ♀, [MCZ]. (5) "Hazleton P[ennsylvani]a, 6[June]/5/[19]02"; "WG Dietz Coll[ection]"; "D Adamski ♀ genitalia slide 2084" [green label]; "Type 2951" [red label]. 1 ♀, [MCZ]. (6) "Toronto Can[ada], 6[June]/2[illegible]/[18]97"; "cotype" [red label]; "WG Dietz coll[ection]"; (specimen is missing abdomen and both hindwings). 1 ♂, [MCZ]. All syntypes are accounted for.

basipallidella (Dietz 1910:27), *Holcocera dives,* var., **n. syn.**

Lectotype here designated: ♂, "June 16/[19]07"; "Cohasset Mass[achusetts]"; "Owen Bryant collector"; "cotype" [red label]; "*H*[*olcocera*] *dives* var. *basipalli-*

della Dietz" [hand-written label]; "USNM ♂ genitalia slide 81004, DA 2434" [green label]. [USNM].

Paralectotypes 1 ♂, 1 ♀. (1) "6[June]/13/1904"; "Hampton N[ew]H[ampshire], SA Shaw [collector]"; "95"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2951" [red label]; "D Adamski ♂ genitalia slide 2082" [green label]. 1 ♂, [MCZ]. (2) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/28/[19]04"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2951" [red label]; "*H*[*olcocera*] *basipallidella* Dietz" [hand-written label]; "D Adamski ♀ genitalia slide 2085" [green label]. 1 ♀, [MCZ]. All syntypes are accounted for.

confluentella (Dietz 1910:36), *Holcocera,* N. SYN., N. COMB.

Lectotype here designated: ♀, "July 5, 1907"; "Cohasset Mass[achusetts]"; "Owen Bryant collector"; "cotype"; "USNM ♀ genitalia slide 80999, DA 2429" [green label]; "*H*[*olcocera*] *confluentella* Dietz" [hand-written label], [USNM].

Paralectotypes 2 ♀. (1) "Cent[ury] N[ew] Y[ork], 6[June]/12/[18]99"; "cotype"; "WG Dietz Coll[ection]"; "Type 2955" [red label]; "D Adamski ♀ genitalia slide 2156" [green label]; 1 ♀, [MCZ]. (2) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/7/[19]02"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2955" [red label]; "*H*[*olcocera*] *confluentella* Dietz, Type" [hand-written label] [specimen is missing abdomen]. 1 ♀, [MCZ]. One syntype is lost.

simplicis (McDunnough 1961:17), *Holcocerina,* N. SYN., N. COMB.

Holotype: ♂. "Armdale, Halifax Co[unty] N[ova] S[cotia], 6/VI[June]/1947, DC Ferguson"; "Slide no. *Hol*[*cocerina*]. 8a, ♂ "[blue label]; "Holotype; *Holcocerina simplicis* McD[unnough], no.7768" [hand-written label], [CNC].

Paratypes 1 ♂, 1 ♀. Both specimens with same data as holotype, except ♀, "Slide no. *Hol*[*cocerina*] 8a, ♀" [blue label], [CNC].

busckiella (Dietz 1910:36), *Holcocera*

Lectotype here designated: ♂, "Plummer's [sic] I[sland] M[arylan]d, July 1903"; "Aug[ust] Busck collector"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2956" [red label]; "*H*[*olcocera*] *busckiella* Dietz" [hand-written label]; "D Adamski ♂ genitalia slide 2067" [green label], [MCZ].

Paralectotypes 5 ♂, 1 ♀. (1) same data as lectotype except, "D Adamski ♂ genitalia slide 2068" [green label]. 1 ♂, [MCZ]. (2), same data as lectotype, except, "USNM ♂ genitalia slide 80994, DA 2424" [green label]. 1 ♂, [USNM]. (3–5) same data as lectotype, each specimen is missing abdomen. 2 ♂, 1 ♀, [USNM]. (6) same data as lectotype, except, "Plummer's [sic] Isl[and], Potomac River, M[arylan]d, at light, Aug[ust] 21, 1902" [hand-written label], (specimen is missing abdomen). 1 ♂, [USNM]. All syntypes are accounted for.

estriatella (Dietz 1910:28), *Holcocera*

Holotype ♂. "July 16/[19]07"; "Cohasset Mass[achusetts]"; "Owen Bryant collector"; "Type" [red label]; "WG Dietz Collection"; "Type 2970" [red label]; "*H*[*olcocera*] *estriatella* Dietz, Type" [hand-written label]; "D Adamski ♂ genitalia slide 2090" [green label], [MCZ].

simuloides (McDunnough 1961:16), *Holcocerina,* N. SYN.

Holotype ♂. "Lake Kejimukujik, Queens Co[unty, N[ova] S[cotia], 2/VI[June]/1958, DC Ferguson"; "Slide no. *Hol*[*cocerina*] 8f, ♂" [blue label]; "Holotype, *Holcocerina simuloides* McD[unnough], no.7767"; [right wing torn at apex], [CNC].

Paratypes 4 ♀. (1–2) same data as holotype except, "May 28, 1958"; and "May 29, 1958"; "Slide no. 8d, ♀" [blue label].

2 ♀, [CNC]. (3, 4) Waverley, Nova Scotia, "May 20, 1951" and "June 1, 1952." 2 ♀, [CNC].

fuscopurpurella (Dietz 1910:9), *Blastobasis plummerella* var., **N. STA.**

Lectotype here designated: ♀, "Plummer's [sic] I[sland], M[arylan]d, July 1903"; "Aug[ust] Busck collector"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2962" [red label]; "D Adamski ♀ genitalia slide 2044" [green label], [MCZ]. One syntype is lost.

irenica (Walsingham 1907a:208), *Catacrypsis*, **N. COMB.**

Holotype ♀. "Type" [red-bordered disc label]; "Mouth of Albion R[iver], Mendocino Co[unty] California, 30-31, V[May]-1871, Wlsm 90429"; "Walsingham Collection, 1910-427"; "BM ♀ genitalia slide 28081"; "*Catacrypsis irenica* Wlsm, Type ♀"; [BMNH].

Paratype 1 ♀. "New Westminster, British Columbia, 13/IV[April]/1900, C. D[u]r-[ra]nt 35873"; "Walsingham Collection, 1910-427"; "*Catacrypsis irenica* Wlsm, paratype 1/1.", [BMNH].

plagiatella (Dietz 1910:40), *Holcocera*

Holotype ♂. "Williams, Ar[izona], 26/7[July]"; "HS Barber collector"; "Type" [red label]; "WG Dietz Collection"; "Type 2957" [red label]; "*H*[*olcocera*] *plagiatella* Dietz"; "D Adamski ♂ genitalia slide 2124" [green label]; [MCZ].

plummerella (Dietz 1910:8), *Blastobasis*

Lectotype here designated: ♂, "Plummer's [sic] I[sland] M[arylan]d, July 1903"; "Aug[ust] Busck collector"; "cotype" [red label]; "WG Dietz Collection"; "Type 2961" [red label]; "*B*[*lastobasis*] *plummerella* Dietz, cotype" [hand-written label]; "D Adamski ♂ genitalia slide 2043" [green label], [MCZ].

Paratypes 3 ♂, 1 ♀. (1) same data as lectotype, except, "28/4[April]/[19]03." Specimen is missing both hindwings and the abdomen. 1 ♂, [MCZ]. (2–4) same data as lectotype, each missing abdomen, and one male missing head. 2 ♂, 1 ♂, [USNM]. One syntype is lost.

protypica Meyrick 1931:178, *Asaphocrita*

Lectotype designated by Clarke (1963: 477): ♂, "Lectotype" [disc label]; "Fort Davis, Texas, 5000′, 10[October]/27"; "Lectotype, *Asaphocrita protypica* Meyrick, JFGC 1948"; "*Asaphocrita protypica* Meyr[ick], 15/1, E[dward Meyrick det., in Meyrick Coll[ection]"; "*Asaphocrita* Meyr"; "*protypica* Meyr"; "Meyrick Coll[ection], BM 1938-290"; [BMNH]. Lectotype is missing left hindwing.

Paralectotypes 1 ♂ 12 ♀. (1) Fort Davis, Texas. 1 ♀, BM. (2–5) Bent, New Mexico. 4 ♀, BM. (6–11) Mescalero, New Mexico. 6 ♀, [BMNH]. (12–13) Bent, New Mexico: "USNM ♂ genitalia slide 80991, DA 2421" [green label]; USNM ♀ genitalia slide 80992, DA 2422" [green label]. 1 ♂, 1 ♀, [USNM]. One syntype is missing.

sciaphilella (Zeller 1873:295), *Blastobasis*

Holotype ♂. "Type 1713" [red label]; "Dallas Tex[as], Boll"; "*Blastobasis sciaphilella* Z[eller]" [green label]; "D Adamski ♂ genitalia slide 2141" [green label], [MCZ].

stygna (Walsingham 1907a:207), *Catacrypsis*, **N. SYN., N. COMB.**

Holotype ♂. "Type" [disc label]; "N[orth] n[ea]r Mendocina [sic] City, California, 3–5, VI[June]/1871, Wlsm 90425"; "*Catacrypsis stygna* Wals., Pr. US Nat. Mus., 33, p. 207 (1907), Type ♂"; [BMNH]. Holotype is missing abdomen.

triangularisella (Chambers 1875a:256), *Holcocera*

Holotype ♂. "Type 1550" [red label]; "Kentucky, Chambers"; "*Holcocera trian-*

gularisella Cham." [hand-written label]; "D Adamski ♂ genitalia slide 2142" [green label], (specimen is missing wings on left side), [MCZ].

HOLCOCERA Clemens 1863:121

CYNOTES Walsingham 1907b:210
EUBOLEPIA Dietz 1910:67
HOLOCERA Dietz 1910:33, missp.

anomalella (Dietz 1910:68), *Eubolepia*

Holotype ♀. "16700"; "Pinal M[ountains], Ariz[ona]"; "Type" [red label]; "*Eubolepia anomalella* Dietz"; "USNM ♀ genitalia slide 81032, DA 2462" [green label], [USNM].

chalcofrontella Clemens 1863:122, *Holcocera*

Holotype ♂. "201"; "Type 7381" [red label], [white Clemens ID label]; "D Adamski ♂ genitalia slide 2843" [green label]. Holotype probably was collected in Easton, Pennsylvania, [ANSP].

purpurocomella Clemens, 1863:122, *Holcocera,* **N. SYN.**

Holotype ♀. "200"; "Type 7383" [red label], [white Clemens ID label]; "D Adamski ♀ genitalia slide 2845" [green label]. Specimen is missing right pair of wings. Holotype probably was collected in Easton, Pennsylvania, [ANSP].

gilbociliella Clemens 1863:122, *Holcocera,* **N. SYN.**

Holotype ♂. "203"; "Type 7382" [red label], [white Clemens ID label]; "D Adamski ♂ genitalia slide 2844" [green label]. Holotype probably was collected in Easton, Pennsylvania, [ANSP].

gibbociliella Forbes 1923:310; Hodges 1983:15; Adamski and Brown 1989: 24, missp.

quisquiliella (Zeller 1873:298), *Blastobasis chalcofrontella* var.

Lectotype here designated: ♂, "Type 1712" [red label]; "Dallas Tex[as], Boll"; "Zeller"; "*Blastobasis quisquiliella* Z[eller]" [green label]; "D Adamski ♂ genitalia slide 2072" [green label], [MCZ].

Paralectotypes 2 ♀. (1–2) same data as lectotype except, one specimen with, "D Adamski ♀ genitalia slide 2073" [green label] (specimen is missing right pair of wings): second specimen is missing abdomen. 2 ♀, [MCZ]. Two syntypes are missing.

livorella (Zeller 1873:299), *Blastobasis,* **N. SYN.**

Holotype ♂. "Type" [disc label]; "Dallas Tex[as], Boll, Hagen, 371, 1871, Zell[er] Coll[ection], 101614"; "*Blastobasis livorella* Z[eller], Texas, H[a]g[en] 71" [green label]; "BM ♂ genitalia slide 28079", [BMNH].

maligemmella (Murtfeldt 1898:5), *Nothris*?, **N. SYN.**

Holotype ♂. "Type no. 401 USNM"; "Jackson Co[unty, M[iss]o[uri]"; "Stedman Collection"; "*Nothris maligemmella* Murtfeldt"; "Bull[etin] 42, Missouri Exp Sta, P. 42"; "Wing slide no. 12298"; "Type 4017" [red label]; "USNM ♂ genitalia slide 81018, DA 2448" [green label]. Specimen is missing right forewing, [USNM].

ochrocephala Dietz 1910:31, *Holcocera,* **N. SYN.**

Lectotype here designated: ♂, "Aurora, W[est] V[irgini]a, Aug[ust]21, 1904"; "O Heidemann collector"; "cotype" [red label], [Id label of Dietz]; "USNM ♂ genitalia slide 81025, DA 2455" [green label]. The specimen was misidentified as female by Dietz (1910:32), [USNM].

Other specimens.—A male specimen from Plummers Island, Maryland is in MCZ. Although the locality data for this

specimen do not agree with "the locality" (Frederick, MD) for the second syntype, it may have been one of the two specimens on which Dietz based the original description for *H. ochrocephala.* Data for this specimen are as follows: "Plummer's [sic] I[sland], M[arylan]d, May [19]03"; "Aug[ust] Busck collector"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2952" [red label]; "*H*[*olcocera*] *ochrocephala* Dietz" [hand-written label]; "D Adamski ♂ genitalia slide 2123" [green label], [MCZ].

minorella Dietz 1910:34, *Holcocera chalcofrontella,* var.

Lectotype here designated: ♂, "Lewisburg, P[ennsylvani]a, Bred from Chest[nut] burrs"; "cotype" [red label]; "MCZ Lectotype 2953" [red label, affixed to pin by Adamski] (specimen is not dissected), [MCZ].

Paralectotypes 1 ♂, 4 ♀. (1–3) same data as lectotype except, they lack cotype labels, and one ♀ with "Dietz-took 3 of these." Specimens are not dissected. 1 ♂, 2 ♀, [MCZ]. (4) "4165a"; "Bred spe[ci]m[en] IV[April]23"; "Lewisburg X[October]/9/[19]05" [hand-written label]; "From burrs of chestnuts" [hand-written label]; "Dep[artmen]t of Agr[iculture] no. 483" [hand-written label]; "cotype" [red label]. Specimen is from the Kearfott Collection. Specimen not dissected and is missing left forewing. 1 ♀, [USNM]. (5) "4165a"; "Lewisburg, P[ennsylvani]a" [hand-written label]; "Bred spe[ci]m[en] III[March]22"; "From burrs of chestnuts" [hand-written label]"; "Dep[artmen]t of Agr[iculture] no. 483" [hand-written label]; "cotype" [red label]. Specimen not dissected and is missing right pair of wings. Specimen is from the Kearfott Collection. 1 ♀, [USNM].

Other specimens.—One ♀ from Lewisburg Pennsylvania, bred from burrs of Chestnuts by NF Davis is in MCZ, but it is not considered one of the original syntypes. In addition, two specimens in MCZ from Hallowell, Pennsylvania bearing cotype label and MCZ type label no. 2953 are not considered part of original syntype series.

fumerella Dietz 1910:35, *Holcocera chalcofrontella,* var.

Lectotype here designated: ♀, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/6/[19]02"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2954" [red label]; "D Adamski ♀ genitalia slide 2074" [green label], [MCZ].

Paralectotypes 7 ♀. (1) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/14/[19]02"; "cotype"; "WG Dietz Coll[ection]"; "Type 2954" [red label]; "*H*[*olcocera*] *chalcofrontella* var. *fumerella* Dietz, Type" [hand-written label]; "D Adamski ♀ genitalia slide 2075" [green label]. 1 ♀, [MCZ]. (2) "Hazleton, P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/3/[18]99"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2954" [red label], (specimen not dissected). 1 ♀, [MCZ]. (3) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t 6[June]/29/[18]90"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2955" [red label] (erroneously labeled), (specimen not dissected). 1 ♀, [MCZ]. (4) "Bred from *Rhus typhosa,* 5[May]/16/[19]06"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2954" [red label]; "D Adamski ♀ genitalia slide 2076" [green label]. 1 ♀, [MCZ]. (5) "Bred from *Rhus typhosa,* V[May]/16/[19]04"; "WG Dietz Coll[ection]" (specimen not dissected). 1 ♀, [MCZ]. (6) "Bred from Sumac racemes, 5[May]/24/[19]06"; "cotype" [red label]; "*H*[*olcocera*] *chalcofrontella* var. *fumerella* Dietz" [hand-written label] (specimen not dissected. 1 ♀, [MCZ]. (7) "Hazleton P[ennsylvani]a, 6[June]/12/19[illegible]"; "cotype" [red label] (specimen missing abdomen). 1 ♀, [MCZ].

reductella Dietz 1910:45, *Holcocera funebra,* var., **N. SYN., REV. COMB.**

Lectotype here designated: ♂, "Criddle

[collector] Aweme Man[itoba], 6/VI[June]/[19]04"; "*Blastobasis phycidella* Z[eller]" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2959" [red label]; "*H*[*olcocera*] *funebra* var. *reductella* Dietz" [hand-written label]; "D Adamski ♂ genitalia slide 2095" [green label]; [MCZ].

Paralectotype 1 ♀. "Criddle, Aweme Man[itoba] 23/IV[April]/[19]03" (specimen is missing abdomen), [USNM].

coccivorella (Chambers 1880:244), *Blastobasis*

The description of *Blastobasis coccivorella* is based on two females from Cedar Key, Florida that were reared from coccid-scales on oak (*Kermes,* near *pallidus* Reaumur). The infested scales were collected in March and issued between April 1–10. The two syntypes apparently are lost.

crassicornella Dietz 1910:32, *Holcocera*

Holotype ♂. "Florida" [hand-written label]; "Type" [red label]; "*H*[*olcocera*] *crassicornella* Dietz, Type." Holotype is missing the abdomen; other body parts are within a gelatin capsule on pin; [USNM].

eriobotryae (Busck 1915:85), *Blastobasis,* N. SYN.

Lectotype here designated: ♂, "From Loquat [*Eriobotrya japonica*], Miami Fl[orid]a, iss[ued] [=emerged]. July 1910" [hand-written label]; "USNM Type no. 19233" [red label], (holotype not dissected), [USNM].

Paralectotypes 7 ♂, 10 ♀. (1–14) "From mummy fruit of Loquat." 5 ♂, 7 ♀, [USNM]; 1 ♂, 1 ♀, [MCZ]. (15) "From dry fruit of Loquat." 1 ♀, [USNM]. (16–17) "From fruit of Loquat." 1 ♂, 1 ♀, USNM. Three USNM paralectotypes: ♂, "USNM ♂ genitalia slide 81573a, DA 3174" [green label]; "*Blastobasis eriobotryae* Busck, Cotype" [hand-written label]; ♀, "USNM female genitalia slide 81574a, DA 3175" [green label]; "*Blastobasis eriobotryae* Busck, Cotype" [hand-written label]; ♀; "USNM ♀ wing slide 81574, DA 3179" [green label]. Two MCZ paralectotypes: ♂, "ex USNM"; "D Adamski ♂ genitalia slide 2040" [green label]; "*Blastobasis eriobotryae* Busck, 466" [hand-written label]; ♀; "ex USNM"; "D Adamski ♀ genitalia slide 2041" [green label].

gargantuella (Heinrich 1920:69), *Eubolepia*

Holotype ♂. "12182, Hopk[ins], U[nited] S[tates]"; "Reared May 7–15"; "WD Edmonston col[lecto]r"; "Geo[rge] Hofer col[lecto]r"; "B[r]ush Corral, Ariz[ona]"; "Galls on White Oak"; "♂ genitalia on slide CH, 13-Dec[ember]-1917"; "USNM Type no. 21810" [red label]; "*Eubolepia gargantuella* Heinrich, Type" [hand-written label], [USNM].

Paratypes 10 ♂, 5 ♀. Of the fifteen paratypes only eight specimens have paratype labels on the pin. Because the remaining seven specimens have the same label data as holotype and the other paratypes, there is no reason to exclude them from the paratype series. All paratypes are in USNM. In addition, several vials of larvae and adults are in the USNM alcohol collection.

Other specimens.—Thirty-six specimens collected from Sabino Canyon, Arizona, reared from galls of Cynipidae by G Hofer are in the USNM Collection. In addition, eleven specimens collected from Baboquivari Mountains, Pima County, Arizona, reared from oak galls by OC Poling are in USNM Collection.

gigantella Chambers 1876:219, *Holcocera*

Lectotype designated by Powell (1976): ♂, "Type 1551" [red label]; "Chambers Color[ado]" [hand-written label]; "*Blastobasis gigantella* Col[orado]." [hand-written label]; "♂"; "Genitalia 4008, JAP'75"; "Lectotype, *Holcocera gigantella* Chamb[ers], By JAP'76"; [MCZ].

Paralectotypes 2 ♂, 2 ♀. Paralectotypes

have same data as the lectotype except: (1) "Genitalia 4009, JAP'75". 1 ♀, [MCZ]. (2) "D Adamski ♀ genitalia slide 2099" [green label]. 1 ♀, [MCZ]. (3) (specimen is missing abdomen). 1 ♂, [MCZ]. (4) "*Blastobasis gigantella* Col." (specimen not dissected). 1 ♂, [USNM].

guilandinae (Busck 1900a:234), *Blastobasis*

Lectotype here designated: ♂, "From stem of *Guilandina bonducella,* iss[ued] [=emerged] Mar[ch] 30, 1900" [hand-written label]; "Palm Beach Fl[orid]a"; "USNM Type no. 4942" [red label]; "*Blastobasis guilandinae* Busck, ♂" [hand-written label]; "USNM ♂ genitalia slide 80980, DA 2410" [green label]; [USNM].

Paralectotype 1 ♀. "From stem of *Guilandina bonducella,* Palm B[each] Fl[orid]a, iss Mar[ch] 30, 1900" [hand-written label]; "Palm Beach Fl[orid]a"; "USNM Type no. 4942" [red label]; "*Blastobasis guilandinae* Busck, Type ♀" [hand-written label]; "USNM ♀ genitalia slide 80977, DA 2407" [green label]. [USNM].

iceryaeella (Riley 1887:484), *Blastobasis*

Lectotype designated by Adamski and Brown (1989): ♂, "Aug[ust]"; "Alameda Co[unty], Cal[ifornia]"; "*B*[*lastobasis*] *iceryaeella* Riley, Type ♂" [hand-written label]; "USNM Type 473" [red label] (specimen is missing abdomen and right forewing); [USNM].

Paralectotypes 2 ♀. (1) "Folsom Cal[ifornia], 1/7, [18]85" [hand-written label]; "101 label, Europe 1884, 1886, no name" [hand-written label]; "*Blastobasis cinereella* Riley, MS, ♀" [hand-written label]; "*Cinere*[*el*]*la* Ril[ey], MS name *only* = *iceryaeella* Riley" [handwrittem label]; "♀ genitalia on slide no. 412, RB Selander"; "USNM Type no. 472" [red label]; "USNM ♀ genitalia slide 81591" [green label] (specimen is missing right forewing), 1 ♀, [USNM]. (2) "Folsom Cal[ifornia], 1/7, [18]85" [hand-written label]; "156"; "Through CV Riley"; "*Blastobasis* spec. Wlsm/86" [hand-written label]; "♀ genitalia on slide no. 409, RB Selander"; "USNM ♀ genitalia slide 81592" [green label]. Two of the original syntypes either are missing or cannot be recognized by label data or by other evidence. According to Riley (1887) the original description of *B. iceryaeella* was based upon four males and one female. We are confident that the three specimens above are from the original syntype series because, 1) the date on label is at least two years prior to publication date, and 2) locality on label, "Folsom, Cal." and "Alameda Co. Cal.", matches that given for "USNM Type 472" and "USNM Type 473" within the USNM [Entomology] Type Catalogue. In addition, Riley (1887) states the specimens were collected by Mr. Koebele. Although the two specimens labeled "USNM Type 472" and "USNM Type 473" do not have a collector's label attached to the pin, the USNM Type Catalogue indicates that they were collected by Mr. Koebele.

phenococci Braun 1927:118, *Holcocera,* **N. SYN.**

Holotype ♀. "Avalon Catalina I[sland], Calif[ornia], Aug[ust] 1926, Cockerell"; "Bred from plant infested with *Phenococcus colemani* Ehrhorn, emerged Sept[ember]"; "Type" [red label]; "*Holcocera phenococci* Braun, Type"; "D Adamski ♀ genitalia slide 2907" [green label], [ANSP].

immaculella McDunnough 1930:269, *Holcocera*

Holotype ♂. "Ottawa Ont[ario] 27/VI-[June]/1927, JH McDunnough"; "Holotype, *Holcocera immaculella* McD., No. 3104" [red label], [CNC].

Paratype 1 ♀. "Kazubazua Que[bec], 7–10/VI[June]/1927, JH McDunnough"; "Allotype, *Holcocera immaculella* McD., No. 3104" [red label]. [CNC].

panurgella Heinrich 1920:71, *Holcocera*

Holotype ♀. "13977, Hopk[ins] U[nited] S[tates]"; "Reared June 16/17"; "G Hofer col[lecto]r"; "S[an]ta Catalina M[oun]t[ains], Ariz[ona]" [hand-written label]; "*Pinus cembroides*" [hand-written label]; "USNM Type no. 21812" [red label]; "*Holcocera panurgella* Heinrich, Type" [hand-written label]; "USNM genitalia slide 81026, DA 2456" [green label]. Holotype has left forewing and both hindwings in a gelatin capsule on pin, [USNM].

paradoxa Powell 1976:224, *Holcocera*

Holotype ♂. "Arizona, Madera Canyon, Santa Rita Mountains, 6 June 1968, reared from remnants of 1967 pods of *Yucca schottii,* em[er]g[e]d 24 September 1968 (J. Powell no. 68F47)." Holotype in California Academy of Sciences, [CAS].

Paratype 1 ♀. Specimen has same data as holotype except, "3 October 1968, reared from 1968 pods of *Y. schottii,* em[er]g[e]d 3 June 1969 (J. Powell no. 68K15).", [UCB].

villella (Busck 1900b:238), *Triclonella,* **N. COMB.** Originally described in Oecophoridae, name omitted by Hodges (1983) and Adamski and Brown (1989).

Holotype ♂. "9216, on *Xolisma* [*Andromeda*] *ligustrina*?, C[abin] J[ohn] B[ridge], M[arylan]d, iss[ued] [= emerged] May 11/1900" [hand-written label]; "USNM ♂ genitalia slide 81572, DA 3163" [green label]; "USNM Type no. 5355" [red label]; "*Triclonella villella* Busck, Type" [hand-written label]. The holotype is missing the left forewing and right hindwing. Originally, it was misidentified as a female.

vilella Dietz 1910:6, missp.

augusti Heinrich 1920:70, *Holcocera,* **N. SYN.**

Holotype ♂. "12536k, Hopk[ins] U[nited] S[tates]"; "Reared May 15/[19]15"; "JE Patterson col[lecto]r" [hand-written label]; "Ashland Ore[gon]"; "*Pseudotsuga taxifolia*"; "♂ genitalia on slide CH-13 Dec[ember]-1917" [hand-written label]; "USNM Type no. 21811" [red label]; "*Holcocera augusti* Heinrich, Type"; [USNM].

Paratypes 12 ♂, 11 ♀, 1 Sex?. Only eleven specimens with red USNM paratype label, however, all with specific Hopkins numbers Heinrich (1920). (1–2) "13266e, Hopk[ins] U[nited] S[tates]." 1 ♂, 1 ♀, [USNM]. (3–17) "12536k, Hopk[ins] U[nited] S[tates]." 7 ♂, 7 ♀, [USNM]. (18) "1080h, Hopk[ins] U[nited] S[tates]." 1 ♀, [USNM]. (19) "10834e, Hopk[ins] U[nited] S[tates]." (1 ♀). (20–22) "10834b4, Hopk[ins] U[nited] S[tates]." 2 ♂, 1 Sex?, [USNM]. (23) "14280g Hopk[ins] U[nited] S[tates]." 1 ♀, [USNM]. (24) paratype with a red USNM paratype label and a red MCZ paratype label, no. 25410, "12536k, Hopk[ins] U[nited] S[tates]"; "D Adamski ♂ genitalia slide 2063"; [green label]. 1 ♂, [MCZ].

CALOSIMA Dietz 1910:21

albapenella (Chambers 1875b:11), *Butalis,* transferred from *Scythris,* Scythrididae, Adamski and Brown (1989).

Holotype ♂. "Tex[as]"; "Chambers"; "45"; "*albapenella* Ch[am]b[ers]" [pale green label], [USNM]. The holotype is mounted on two microscope slides: JFL-85-0290a [USNM 81583], right forewing and hindwing; JFL-85-0290b [USNM 81584], head, thorax, and male genitalia.

citricolella (Chambers 1880:206), *Blastobasis,* **N. SYN., N. COMB.**

Lectotype here designated: ♀, "No. 457, From dry orange, Jacksonville Fl[orid]a, Iss March 17/[19]80"; "USNM Type no. 3774" [red label]; "3688, Wlsm 1899"; "*Blastobasis citricolella* Cham." [hand-written label]; "*Blastobasis*(?) *citricolella*

Chamb., ♀, named by D[u]r[ra]nt" [handwritten label]; "*Comstockia citricolella*" [manuscript name], [USNM]. The holotype is missing the right forewing, left hindwing, and abdomen.

Paralectotype 1 ♀. "1101P., *Tinea* from granite apple, iss Apr[il] 21/[18]79" [handwritten label]; "*T*[*inea*] *citricolella* Ch[ambers]" [hand-written label]; "USNM ♀ genitalia slide 80981, DA 2411" [green label]. [USNM].

nana (Dietz 1910:48), *Holcocera,* **N. SYN., N. COMB.**

Holotype ♀. "Brownsville Tex[as], 9/V[May]/[19]04"; "HS Barber collector"; "Type" [red label]; "*H*[*olcocera*] *nana* Dietz", (specimen is missing abdomen), [USNM].

argyrosplendella Dietz 1910:22, *Calosima*

Lectotype designated by Adamski and Brown (1989): ♂, "Hazleton P[ennsylvani]a, 7[July]/4/[19]06"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2968" [red label]; "*C*[*alosima*] *argyrosplendella* Dietz, Cotype" [hand-written label]; "D Adamski ♂ genitalia slide 2059" [green label], [MCZ].

Paratypes 1 ♂, 1 ♀. (1) "Hastings Fl[orid]a, 5[May]/16/[19]02"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2968" [red label]; "D Adamski ♀ genitalia slide 2060" [green label]; "*C*[*alosima*] *argyrosplendella* Dietz, Cotype" [hand-written label] (specimen is missing right pair of wings). 1 ♀, [MCZ]. (2) "Vowells Mill L[ouisian]a, 4[April]/[19]02"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2968" [red label]; "*C*[*alosima*] *argyrosplendella* Dietz, Cotype" [hand-written label]. Specimen is missing right hindwing and abdomen. 1 ♂, [MCZ]. All syntypes are accounted for.

dianella Dietz 1910:22, *Calosima*

Holotype ♂. "Forsyth G[eorgi]a, [18]-95"; "Type" [red label]; "WG Dietz Coll[ection]"; "Type 2969" [red label]; "*C*[*alosima*] *dianella* Dietz, Type" [handwritten label]; "D Adamski ♂ genitalia slide 2061" [green label]; [MCZ].

lepidophaga (Clarke 1960:115), *Holcocera,* **N. SYN.**

Holotype ♂. "Baker Co[unty] Fl[orid]a, Coll[ected] 2[February]/20/[19]58, reared 4[April]/20/[19]58, *Pinus elliotti,* ♂ fl[ower] buds"; "MR 19, Coll[ector] BH Ebel"; "Hopk[ins] U[nited] S[tates] 40170"; "♂ genitalia on slide 17/VIII/1959, JFGC 10753"; "TYPE, *Holcocera lepidophaga* Clarke" [red label], [USNM].

Paratypes 4 ♂, 3 ♀ in USNM. According to Clarke (1960), additional paratypes are found in Canadian National Collection [CNC], Illinois State Natural History Survey [INHS], State Plant Board of Florida, Gainesville [FSCA], but were not examined. Several preserved larvae, collected by B. Ebel are in the Lepidoptera alcohol collection at USNM.

elyella (Dietz 1910:49), *Holcocera*

Lectotype here designated: ♂, "East River, Conn[ecticut], VIII[August]/19/[19]07"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2941" [red label]; "D Adamski ♂ genitalia slide 2087" [green label]; "*H*[*olcocera*] *elyella* Dietz" [handwritten label], [MCZ].

Paralectotypes 9 ♂. (1–2) "East River, Conn[ecticut], VIII[August]/25/[19]07"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2941" [red label]; "D Adamski ♂ genitalia slide 2086" [green label] (one specimen is missing head, the other specimen is missing distal half of the left forewing). 2 ♂, [MCZ]. (3) "East River, Conn[ecticut], 8[August]/15/[19]06"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2941" [red label]. 1 ♂, [MCZ]. (4) "7[July]/3/[19]06"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2941" [red label]. 1 ♂, [MCZ]. (5–

7) "Plummer's [sic] I[sland], M[arylan]d July 9, 1902"; "Aug[ust] Busck Collector"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2941" [red label] (one specimen is missing abdomen, another specimen is missing an abdomen and the right pair of wings). 3 ♂, [MCZ]. (8) "Ess[ex] Co[unty] P[ar]k, N[ew] J[ersey], WD Kearfott [collector], Aug[ust] 16, Trap". 1 ♂, [MCZ]. (9) "Frederick M[arylan]d, VII[July]/21/[19]06"; "WG Dietz Coll[ection"; "D Adamski ♂ genitalia slide 2088" [green label]. 1 ♂, [MCZ]. Seven of the original syntypes apparently are lost.

Other specimens.—An additional 20 specimens of *C. elyella* collected by Charles R. Ely from East River are in MCZ. Some of them could be part of the original syntype series; however, there is no evidence to support this.

lucidella Adamski, *in* Adamski and Brown 1989:18, *Calosima*

Holotype ♂. "Florida, Lake Placid, Archbold Bio[logical] Sta[tion], 1–7 May 1964, RW Hodges"; "USNM ♂ genitalia slide 81081, DA 2511" [green label], [USNM].

Paratypes 1 ♂, 5 ♀. Same data as holotype except; (1) "1–8 June 1964". 1 ♀, [USNM]. (2–4) "16–22 June 1964"; "USNM ♀ genitalia slide 81082, DA 2512" [green label], and "USNM wing slide USNM 81196, DA 2627" [green label]; "USNM ♀ genitalia slide 81468, DA 2996" [green label]. 3 ♀, [USNM]. (5) "1–7 May 1964"; "USNM ♂ wing slide 81195, DA 2626" [green label]. 1 ♂, [USNM]. (6) "27 March 1959"; not dissected. 1 ♀, [USNM]. All paratypes are in USNM.

melanostriatella (Dietz 1910:66), *Holcocera*

Lectotype here designated: ♂, "East River, Conn[ecticut], 9[September]/3/[19]06"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2937" [red label]; "D Adamski genitalia slide 2111" [green label], [MCZ].

Paralectotypes 5 ♂. (1) "East River, Conn[ecticut], 7[July]/29/[19]06"; "WG Dietz Coll[ection]"; "cotype" [red label]; "Type 2937" [red label] (specimen missing abdomen). 1 ♂, [MCZ]. (2) "East River, Conn[ecticut], VIII[August]/[illegible]/[19]07"; "cotype" [red label, "WG Dietz Coll[ection]"; "Type 2937" [red label] (specimen not dissected). 1 ♂, [USNM]. (3) "East River, Conn[ecticut], 7[July]/25/[19]06"; "cotype" [red label]; "Type 2937" [red label], (specimen missing right pair of wings). 1 ♂, [USNM]. (4) "East River, Conn[ecticut], 7[July]/25/[19]06"; "cotype" [red label]; "Type 2937" [red label], (specimen missing abdomen and left pair of wings). 1 ♂, [USNM]. (5) "Hazleton P[ennsylvania], 8[August]/12/[19]07"; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2937" [red label]; "*H*[*olcocera*] *melanostriatella* Dietz" [hand-written label] (specimen missing abdomen). 1 ♂, [USNM]. One paralectotype apparently is lost. Three specimens from East River, Connecticut, collected July and August 1909 are in the MCZ, one of which may be the missing syntype.

melonostriatella Dietz 1910:66, missp.

BLASTOBASINI Meyrick 1894:22

REVISED STATUS

BLASTOBASIS Zeller 1855:171

EPISTETUS Walsingham 1894:552
VALENTINIA Walsingham 1907a:200
ZENODOCHIUM Walsingham 1908a: 52
PROSTHESIS Walsingham 1908b:953
EURESIA Dietz 1910:20
BLASTORASIS Dietz 1910:69 missp.

confamulella (Heinrich 1921:818), *Holcocera*

Holotype ♂. "Heinrich 23b, FHB[arber] rearing" [hand-written label], "Reared

Apr[il]/10/[19]19"; "C[arl] Heinrich Col-[lecto]r"; "Smith P[oint], [Brownsville], Texas" [hand-written label], "*Crategus*" [sic], [hand-written label]; "♂ genitalia and wing on slide CH-26 July 1920" [hand-written label]; "*Holcocera confamulella* Heinrich, Type" [hand-written label]; "USNM Type no. 23742" [red label], [USNM].

Paratypes. Heinrich stated (1921) that five specimens, "one male type and four male and female paratypes" made up the original series from which *H. confamulella* was described. In addition to the holotype there are five specimens (2 ♂, 3 ♀), each bearing a USNM red type label, no. 23742. No explanation is given for this discrepency. We herein treat all five specimens as paratypes. Label data for these specimens are the same as the holotype except: ♂, "USNM ♂ genitalia slide 80997, DA 2427" [green label]; ♀, "Hindwing on slide, Jan[uary] 18, 1956, RBS no. 7" [hand-written label]; "USNM ♀ genitalia slide 80998, DA 2428" [green label].

confectella (Zeller 1873:303), *Hypatima*

Holotype ♀. "Dallas Tex[as], Boll"; "Zeller"; "*Hypatima* sp, ♀", "Anmerkung [illegible] *subsenella*" [hand-written green label], "Type 2083" [red label], (specimen missing left forewing, apex of right forewing, and abdomen, [MCZ].

floridella (Dietz 1910:17), *Valentinia*

Lectotype here designated: ♂, "From ♂ cone of *Zamia integrifolia*" [hand-written label]; "Iss[ued] [= emerged] 4/June/[18]95, Crescent City Fl[orid]a" [hand-written label]; "cotype" [red label]; "*V*[*alentinia*] *livorella* Zell[er]" [hand-written label]; "*V*[*alentinia*] *livorella* Dietz, label is in error" [hand-written label]; "*Valentinia floridella* Dietz, Cotype, ♂, Det. RB Selander 1956" [hand-written label], "USNM ♂ genitalia slide 80985, DA 2415" [green label], [USNM].

Paralectotypes 3 ♀. (1) same label data as lectotype except, "*V*[*alentinia*] *floridella* Dietz, Cotype" [hand-written label] (specimen not dissected). 1 ♀, [USNM]. (2) same label data as lectotype except missing locality label (specimen not dissected). 1 ♀, [USNM]. (3) "On ♂ cone of *Zamia integrifolia,* 7/June/[18]95" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2966" [red label]; "*V*[*alentinia*] *floridella* Dietz, Cotype" [hand-written label] (specimen missing abdomen). 1 ♀, [MCZ].

Other specimens.—One male specimen in MCZ may have been omitted by Dietz; however, we do not treat it here as one of the original syntypes. It bears the following data: "April"; "Fl[orida]"; "Collection, GD Hulst"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2966" [red label]; "D Adamski ♂ genitalia slide 2052" [green label]; "*V*[*alentinia*] *floridella* Dietz, Cotype" [hand-written label] (specimen has metathorax and hindwings within gelatin capsule. Twelve additional specimens (9 ♂, 3 ♀) with same data as lectotype (but these are not part of the cotype series of Dietz) are in the USNM.

glandulella (Riley 1871:118), *Gelechia*

Lectotype designated by Adamski and Brown (1989): ♀, "USNM Type no. 471" [red label]; "*Blastobasis glandulella* Riley" [hand-written label]; "USNM ♀ genitalia slide 81479, DA 3013" [green label], [USNM].

Other specimens.—Seven additional specimens from USNM were examined that may be part of the original syntype series, but there is no evidence from the literature to suggest this: ♂, no label data and missing abdomen; ♂, "65"; "741"; "*Blastobasis glandulella* Riley" [hand-written label], ♂, "178"; "104"; "*Blastobasis glandulella* Riley" [hand-written label]; ♂, "Collection CV Riley"; "25"; "1210"; "*Blastobasis nubilella* Zeller? = *Blastobasis glandulella* Riley?, WLSM" [hand-written label]; ♀, "742"; "*Blastobsis glandulella* Riley"

[hand-written label]; ♀, *Blastobasis glandulella* Riley" [hand-written label]; ♀, "From jar, acorn moth, June 15/[18]71" [hand-written label] (specimen missing hindwings and abdomen).

modestella (Clemens 1863:122), N. SYN., *Holcocera,* pending ruling of ICZN to suppress this senior synonym.

Holotype ♀. "204"; "Type 7384" [red label], [White Clemens ID label]. Holotype is missing abdomen, left pair of wings and right hindwing. Holotype probably was collected in Easton, Pennsylvania, [ANSP].

nubilella Zeller 1873:297, *Blastobasis*

Holotype ♀. "Dallas, Texas, Boll"; "Zeller"; "*Blastobasis nubilella*" [green label]; "Type 1714" [red label]; "D Adamski ♀ genitalia slide 2054" [green label], [MCZ].

nothrotes (Walsingham 1907a:202), *Valentinia*

Holotype ♂. "Type" [disc label]; "Arizona, Morrison, 1883, 35536" [hand-written label]; "Walsingham Collection, 1910-427"; "*Valentinia nothrotes,* Wlsm, Type ♂, desc[ription]"; "BM ♂ genitalia slide 23885"; [BMNH].

pulchella (Dietz 1910:20), *Euresia*

Holotype ♂. "Washington DC, Jun[e]/1902" [hand-written label]; "WG Dietz Coll[ection]"; "Type 2967" [red label]; "D Adamski ♂ genitalia slide 2058" [green label]; [MCZ].

pulebella Dietz 1910:20, missp.

maritimella McDunnough 1961:5, *Blastobasis* N. SYN.

Holotype ♂. "Boulderwood, Halifax N[ova] S[cotia], 14/VIII[August]/1959, DC Ferguson"; "Slide no. *Blast*[*obasis*] 1b" [hand-written label]; "Holotype, *Blastobasis maritimella,* McD[unnough], no. 7764" [red label]; [CNC].

Paratypes. Six male paratypes in CNC, each with same label data as holotype except some specimens with, "August 11, 1959."

quaintancella (Dietz 1910:15), *Valentinia*

Lectotype here designated: ♂, "Quaintance No. 858"; "cotype" [red label]; "*V*[*alentinia*] *quaintancella* Dietz" [hand-written label]; "*V*[*alentinia quaintancella,* ♂ genitalia on slide A[ugust] B[usck] Nov[ember]/20/1907" [hand-written label], "USNM ♂ genitalia slide 11293 by C[arl] Heinrich" [green label]; [USNM].

Paralectotypes 5 ♀. (1) "Quaintance No. 881"; "cotype" [red label]; "*V*[*alentinia*] *quaintancella* Dietz, Cotype" [hand-written label]; "USNM ♀ genitalia slide 80985, DA 2416" [green label], (specimen is not spread). 1 ♀, [USNM]. (2) "Quaintance No. 889"; "cotype" [red label]; "*V*[*alentinia*] *quaintancella* Dietz, Cotype" [hand-written label] (specimen is not spread). 1 ♀, [USNM]. (3) "Quaintance No. 889"; "cotype" [red label], "*V*[*alentinia*] *quaintancella* Dietz, Cotype" [hand-written label]; "*V*[*alentinia*] *quaintancella,* ♀ genitalia on slide A[ugust] B[usck] Nov[ember]/20/1907" [hand-written label] (specimen is not spread). 1 ♀, [USNM]. (4) "Quaintance No. 859"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2965" [red label]; "*V*[*alentinia*] *quaintancella* Dietz, Cotype" [hand-written label]; "D Adamski ♀ genitalia slide 2055" [green label]. 1 ♀, [MCZ]. (5) "Quaintance No. 824"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2965" [red label], "*V*[*alentinia*] *quaintancella* Dietz, Cotype" [hand-written label]; "D Adamski ♀ genitalia slide 2056" [green label]. 1 ♀, [MCZ].

Other specimens.—Ten additional unspread specimens are in USNM, most of which bear separate Quaintance numbers

and are not part of the cotype series of Dietz.

repartella (Dietz 1910:19), *Valentinia*

Lectotype here designated: ♂, "[E] Oslar [Collector], Denver Col[orado]"; "Type" [red label]; "*Valentinia repartella* Busck, Type!" [hand-written label]; "USNM ♂ genitalia slide 80987, DA 2417" [green label]. Holotype is missing right forewing, [USNM].

Paralectotype 1 ♂. "[E] Oslar [Collector], Denver Col[orado"; "*Valentinia repartella* Busck, Cotype" [hand-written label]; "cotype" [red label]; "*V*[*alentinia*] *repartella* Dietz, Cotype" [hand-written label]; "USNM wing slide 11253, by A Busck" [green label]. Specimen is missing left pair of wings and has the dissected male genitalia in a glycerine vial, [USNM].

retectella Zeller 1873:297, *Blastobasis*

Holotype ♀. "Bosque Co[unty] Texas, 2/IX[September]/1876, Belfrage 33097"; "Walsingham Collection 1910-427." Holotype has a badly damaged abdomen, dissection is not warranted, [BMNH].

fractilinea Zeller 1873:298, *Blastobasis,* N. SYN.

Lectotype here designated: ♂, "Type" [disc label]; "Bosque Co[unty] Texas, 19/VIII[August]/1870"; "Belfrage, Lederer 1874, Zell[er] Coll[ection] 101612" [hand-written label], "Zeller Coll[ection], Walsingham Collection, 1910-427"; "*Blastobasis fractilinea* Z[eller], Texas [illegible] 71" [green label]; "*Blastobasis fractilinea* Z[eller], Verh. ZB, Ges. Wien XXIII 298, pl. IV, 37(1873), Type ♂, descr[iption], fig[ure]d" [hand-written label]; "BM ♂ genitalia slide 23884"; [BMNH].

Paralectotype 1 ♂. "Bosque Co[unty] Texas, 1/III[March]/1870, Balfrage Lederer 1871" [hand-written label]; "Zeller Coll[ection] 101613" [hand-written label], "*Blastobasis fractilinea* Z[eller], Texas, [illegible] [18[71" [green hand-written label]; "Zeller Coll[ection], Walsingham Collection, 1910-427"; "*Blastobasis fractilinea* Z[eller], Verh. ZB, Ges. Wien XXIII, 298, Pl. IV, 37(1873), Paratype1/1" [hand-written label], [BMNH].

yuccaecolella Dietz 1910:7, *Blastobasis*

Lectotype here designated: ♂, "7504, iss[ued] [=emerged] Apr[il]/21/[18]97" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2979" [red label]; "D Adamski ♂ genitalia slide 2047" [green label]; "*Blastobasis yuccaecolella* Dietz, Cotype" [hand-written label]; [MCZ].

Paralectotypes 1 ♀, 3 ♂. (1) same data as lectotype except: "iss[ued] [= emerged] Apr[il]/24/[18]97"; "D Adamski ♀ genitalia slide 2048" [green label]; "*B*[*lastobasis*] *yuccaecolella* Dietz, Cotype" [hand-written label]. 1 ♀, [MCZ]. (2) "cotype" [red label]; "*B*[*lastobasis*] *yuccaecolella* Dietz, Cotype" [hand-written label]. 1 ♀, [USNM]. (3) "7104, iss[ued] [= emerged] Apr[il]/24/[18]97" [hand-written label]; "cotype" [red label]; "*B*[*lastobasis*] *yuccaecolella* Dietz, Cotype" [hand-written label]; "Abdomen found in unit tray RB S-[elander], [19]56" [hand-written label], (specimen has abdomen within gelatin vial). 1 ♀, [USNM]. (4) "7504, On *Yucca baccata,* Nuecestown, Tex[as], iss[ued] [= emerged] Apr[il]/18/[18]97" [hand-written label]; "cotype" [red label]; "*B*[*lastobasis*] *yuccaecolella* Dietz, Cotype" [hand-written label] (specimen has genitalia in gelatin vial). 1 ♀, [USNM].

Other specimens.—Fifty-eight additional specimens with the same or similar label data are in the USNM.

HYPATOPA Walsingham 1907a:211

PROSODICA Walsingham 1907a:200
CATACRYPSIS Walsingham 1907a:206
CATACRYPRIS Dietz 1910:2 missp.
PRORODICA Dietz 1910:23 missp.

BLASTOBASOIDES McDunnough 1961:6

annulipes (Dietz 1910:58), N. STA., *Holcocera,* var. of *Holcocera crescentella* Dietz

Holotype ♂. "Baboquivaria [sic], M[oun]t[ain]s, Ariz[ona], FH Snow"; "Type" [red label]; "WG Dietz Coll[ection]"; "Type 2950" [red label]; "*H*[*olcocera*] *crescentella* var. *annulipes* Dietz" [hand-written label] (specimen is missing abdomen); [MCZ].

boreasella (Dietz 1910:47), *Holcocera*

Lectotype here designated: ♀, "Webster, N[ew] H[ampshire], 8[August]/22/1900" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2960" [red label]; "D Adamski ♀ genitalia slide 2065" [green label]; [MCZ].

Paralectotypes 4 ♀. (1) same label data as lectotype except, "D Adamski ♀ genitalia slide 2064" [green label]; "*H*[*olcocera*] *boreasella* Dietz" [hand-written label]. 1 ♀, [MCZ]. (2) same data as lectotype except, "D Adamski ♀ genitalia slide 2066" [green label]. 1 ♀, [MCZ]. (3) same data as lectotype except, "Montreal [Canada], 10/8[August]/[19]00"; "cotype" [red label]. 1 ♀, [MCZ]. (4) "♀ genitalia on slide no. 701, RB Selander"; "USNM ♀ genitalia slide 11138, by RB Selander" [green label]; "*H*[*olcocera*] *boreasella* Dietz" [hand-written label]. 1 ♀, [USNM]. One syntype is lost.

crescentella (Dietz 1910:57), *Holcocera*

Holotype ♀. "Stockton, Utah, VII[July]/9/[190]7, Tom Spalding"; "Type" [red label]; "WG Dietz Coll[ection]"; "Type 2949" [red label]; "D Adamski ♀ genitalia slide 2081" [green label]; "*H*[*olcocera*] *crescentella* Dietz" [hand-written label], [MCZ].

fluxella (Zeller 1873:301), *Blastobasis*(?)

Holotype ♂. "Dallas Tex[as], Boll"; "Type 1711" [red label]; "*Blastobasis fluxella* Z[eller]" [green label]; "D Adamski ♂ genitalia slide 2091" [green label] (specimen is missing right pair of wings), [MCZ].

zelleriella (Dietz 1910:62), *Holcocera,* N. SYN.

Lectotype here designated: ♂, "Dallas Tex[as], Boll"; "Type 2081" [red label]; "*Hypatima subsenella*?, Ann[erkung] 2, [illegible]" [hand written, faded green label]; "Zeller"; "*Holcocera zelleriella* Dietz, Cotype" [hand-written label]; "D Adamski ♂ genitalia slide 2148" [green label], [MCZ].

Paralectotype 1 ♂. "Type 2081" [red label]; "*Hypatima subsenella*?, An[erkung] 2, [illegible]" [hand-written, faded green label]; "*Holcocera zelleriella* Dietz, Cotype" [hand-written label]; "D Adamski ♂ genitalia slide 2149" [green label], [MCZ].

annectella (Dietz 1910:63), *Holcocera,* var. of *zelleriella* Dietz N. SYN.

Lectotype here designated: ♀, "Vowells Mill L[ouisian]a, 4[April]/[19]02"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2932" [red label]; "D Adamski ♀ genitalia slide 2151" [green label], [MCZ].

Paralectotype 1 ♀. "Iowa City, Wickham, VI[June]/29/[18]98"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2932" [red label]; "*H*[*olcocera*] *zelleriella* var. *annectella* Dietz" [hand-written label]; "D Adamski ♀ genitalia slide 2150" [green label] (specimen missing right forewing), [MCZ].

pusilla (Dietz 1910:65), *Holcocera,* N. SYN.

Holotype ♂. "Brownsville Tex[as], 28/4[April]/[19]04"; "Type" [red label]; "WG Dietz Coll[ection]"; "Type 2935" [red label]; "D Adamski ♂ genitalia slide 2139" [green label]; "*H*[*olcocera*] *pusilla* Dietz" [hand-written label], [MCZ].

funebra (Dietz 1910:44), *Holcocera*

Lectotype here designated: ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, VIII-[August]/[illegible]/[19] [illegible]"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2958" [red label]; "D Adamski ♂ genitalia slide 2092" [green label], [MCZ].

Paralectotypes 2 ♂, 2 ♀. (1) "Plummer's [sic] I[sland], M[arylan]d June/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2958" [red label]; "*H*[*olcocera*] *funebra* Dietz" [hand-written label] (specimen is missing abdomen). 1 ♂, [MCZ]. (2) "Plummer's [sic] I[sland], M[arylan]d, May/[19]03"; "Aug[ust] Busck Collector"; "cotype" [red label]; "*funebra*" [hand-written label]; "♀ genitalia on slide no. 681, RB Selander"; "USNM genitalia slide 11133, by RB Selander" [green label]. 1 ♀, [USNM]. (3) "Plummer's [sic] I[sland], M[ary-fjlan]d, May/[19]03"; "Aug[ust] Busck Collector"; "cotype" [red label] (specimen is missing abdomen). 1 ♂, [USNM]. (4) "Plummer's [sic] I[sland], M[arylan]d, May/[19]03"; "Aug[ust] Busck Collector"; "cotype" [red label]; "*H*[*olcocera*] *funebra* Dietz" [handwriten label] (specimen is missing abdomen). 1 ♀, [USNM]. All syntypes are accounted for.

hulstella (Dietz 1910:7), *Blastobasis*

Holotype ♀. "GD Hulst Collection"; "Type" [red label]; "WG Dietz Coll[ection]"; "Type 2977" [red label]; "D Adamski ♀ genitalia slide 2042" [green label]; "*B*[*lastobasis*] *hulstella* Dietz, Type" [hand-written label] (specimen has right hindwing in gelatin capsule), [MCZ].

illibella (Dietz 1910:57), *Holcocera*

Lectotype here designated: ♂, "Frederick M[arylan]d, VII[July]/17/[19]06"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2948" [red label]; "D Adamski ♂ genitalia slide 2101" [green label] (specimen is missing right pair of wings), [MCZ].

Paralectotypes 2 ♂. (1) "Frederick M[arylan]d, VI[June]/16/[19]06"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2948" [red label]; "D Adamski ♂ genitalia slide 2102" [green label]. 1 ♂, [MCZ]. (2) "Frederick M[arylan]d, VII[July]/20/[19]06"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type" [red label]; "*H*[*olcocera*] *illibella* Dietz" [hand-written label], (specimen is missing abdomen). 1 ♂, [MCZ]. All syntypes are accounted for.

inconspicua (Walsingham 1907a:208), *Catacrypsis*

Holotype ♂. "Type" [disc label]; "Hatchet Creek, Shasta Co[unty] California, 14-17/VII[July]/1871, Wlsm 90433"; "Walsingham Collection, 1910-427"; "*Catacrypsis inconspicua* Wlsm, Pr. US Nat. Mus., 33, p. 208 (1907), Type ♂" [hand-written label; "BM ♂ genitalia slide 28077"; [BMNH].

Paratypes 4 ♂. (1–3) same label data as holotype. 3 ♂, BMNH. (4) same label data as holotype except; "Wlsm 90436"; "USNM type no. 10669" [red label]; "♂ genitalia on slide no. 700, RB Selander"; "USNM ♂ genitalia slide 81593" [green label].

insulatella (Dietz 1910:50), *Holcocera*

Lectotype here designated: ♂, "Glenwood Springs Col[orado, Aug[ust]/[18]-99";"Type" [red label]; "WG Dietz Coll[ection]"; "Type 2942" [red label]; "*H*[*olcocera*] *insulatella* Dietz" [hand-written label], [MCZ].

Paralectotype 1 ♂. Same label data as lectotype except, "Sept[ember]/[18]99"; "D Adamski ♂ genitalia slide 2105" [green label], [MCZ]. One additional specimen in the MCZ with same label as lectotype except, "D Adamski ♂ genitalia slide 2106" [green label], and is not considered part of

the original syntype series. All syntypes accounted for.

rufopunctella (Dietz 1910:65), *Holcocera,* **N. SYN.**

Holotype ♀. "Denver, Col[orado], [18]97"; "Type" [red label]; "WG Dietz Coll[ection]"; "Type 2936" [red label]; "D Adamski ♀ genitalia slide 2140" [green label]; "*H*[*olcocera*] *rufopunctella* Dietz" [hand-written label], [MCZ].

interpunctella (Dietz 1910:67), *Holcocera*

Lectotype here designated: ♂, "Stockton Ut[ah], IX[September]/[190]7"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2938" [red label]; "D Adamski ♂ genitalia slide 2109" [green label], [MCZ].

Paralectotypes 1 ♂, 1 ♀. (1) "Stockton Ut[ah], VII[July]/4/[190]7"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2938" [red label]; "D Adamski ♂ genitalia slide 2107" [green label]; "*H*[*olcocera*] *interpunctella* Dietz" [hand-written label]. 1 ♂, [MCZ]. (2) "Stockton Ut[ah], VII[July]/18/[190]7, Tom Spalding"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2938" [red label]; "D Adamski ♀ genitalia slide 2108" [green label]. 1 ♀, [MCZ]. Both paralectotypes = *H. crescentella* (Dietz). All syntypes are accounted for.

messelinella (Dietz 1910:52), *Holcocera*

Lectotype here designated: ♂, "Hastings Fl[orid]a, [illegible]/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2945" [red label]; "D Adamski ♂ genitalia slide 2116" [green label] (specimen is missing right forewing), [MCZ].

Paralectotype 1 ♂. "Frederick M[aryland]d VI[June]/12/[illegible]"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2945" [red label]; "D Adamski ♂ genitalia slide 2115" [green label]; "*H*[*olcocera*] *messelinella* Dietz" [hand-written label], [MCZ]. All syntypes are accounted for.

morrisoni (Walsingham 1907a:209), *Catacrypsis*

Holotype ♂. "Type" [disc label]; "Arizona, Morrison, 1882, 35527"; "Walsingham Collection, 1920-427"; "*Catacrypsis morrisoni* Wlsm, Pr. US Nat [Mus], 33, p. 209 (1907), Type ♂"; "BM ♂ genitalia slide 28080"; [BMNH].

nigrostriata (Walsingham 1907a:204), *Holcocera*

Holotype ♀. "Type" [disc label]; "Arizona, Morrison, 1883, 35531"; "Walsingham Collection, 1910-427"; "*Holcocera nigrostriata* Wlsm, Proc. US Nat. Mus. 33, p. 208 (1907), Type ♀" [hand-written label] (specimen is missing abdomen), [BMNH].

Paratype 1 ♀. "Arizona, Morrison 1883, 35532"; "1620, Wlsm. 1907"; "USNM Type no. 10672" [red label]; "*Holcocera nigrostriata* Wlsm, Paratype 1/1, ♀" [hand-written label], "USNM ♀ genitalia slide 81011, DA 2451" [green label], [USNM].

nigristriata Dietz 1910:29, missp.

nucella (Walsingham 1907a:206), *Catacrypsis*

Lectotype designated by Adamski and Brown (1989): ♂, "Type" [disc label]; "Loveland Colorado, IX[September]/1891, Smith 1891, 30646"; "Walsingham Collection, 1910-427"; "*Catacrypsis nucella* Wlsm, Pr. US Nat. Mus. 33, p. 206 (1907) Type ♂, descr[iption]" [hand-written label], (specimen not dissected), [BMNH]. Twenty-two paratypes in BMNH and seven paratypes in USNM.

punctiferella (Clemens 1863:119), *Gelechia*

Holotype (Sex?). "193" [hand-written label]; "Type 7380, *Gelechia punctiferella,* Clemens" [red label], [white Clemens ID label]. The holotype probably was collected in Easton, Pennsylvania, [ANSP]. Abdo-

men and other characters used to sex the animal are missing.

subsenella (Zeller 1873:302), *Hypatima,* var. *Holcocera punctiferella* Clemens, **N. SYN.**

Holotype ♂. "Dallas Tex[as], Boll"; "*Hypatima subsenella* Z[eller]" [hand-written green label]; "Type 1716" [red label]; "D Adamski ♂ genitalia slide 2126" [green label] (specimen is missing left pair of wings, and right forewing is in a gelatin capsule), [MCZ].

clemensella (Chambers 1874b:246), *Holcocera,* **N. SYN.**

Holotype ♂. "Kentucky, Chambers"; "Type 2947" [red label], "D Adamski ♂ genitalia slide 2079" [green label], "*Holcocera clemensella* Cham[bers" [hand-written label] (specimen is missing left pair of wings, and the right pair of wings are not spread), [MCZ].

tartarella (Dietz 1910:64), *Holcocera,* **N. SYN.**

Lectotype here designated: ♂, "Plummer's [sic] I[sland] M[arylan]d, Jun[e]/[19]03"; "cotype" [red label]; "Aug[ust] Busck Collector"; "WG Dietz Coll[ection]"; "Type 2934" [red label]; "D Adamski ♂ genitalia slide 2146" [green label], [MCZ].

Paralectotypes 3 ♂, 4 ♀. (1) "Plummer's [sic] I[sland] M[arylan]d, July/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "MCZ Paratype 2934" [red label]; "D Adamski ♀ genitalia slide 2147" [green label]; "*Holcocera tartarella* Dietz" [hand-written label]. 1 ♀, [MCZ]. (2) "Plummer's [sic] I[sland] M[arylan]d, June/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2934" [red label]; "*H*[*olcocera*] *tartarella* Dietz" [hand-written label] (specimen is missing right forewing, and is not dissected). 1 ♀, [MCZ]. (3) "Plummer's [sic] I[sland M[arylan]d, May/[19]03"; "Aug[ust] Busck Collector"; "O"; "cotype" [red label]; "USNM ♂ genitalia slide 81037, DA 2467" [green label]; "*H*[*olcocera*] *tartarella* Dietz" [hand-written label]. 1 ♂, [USNM]. (4) "Plummer's [sic] I[sland] M[arylan]d, June/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "♂ genitalia on slide no. 706, RB Selander"; "USNM genitalia slide 11388, by RB Selander" [green label]. 1 ♀, [USNM]. (5) "Plummer's [sic] I[sland] M[arylan]d, Jun[e]/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "♂ genitalia on slide no. 707, RB Selander"; "USNM genitalia slide 11389, by RB Selander" [green label]. 1 ♂, [USNM]. (6) "Plummer's [sic] I[sland] M[arylan]d, Jun[e]/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "♀ genitalia on slide no. 705, RB Selander"; "USNM genitalia slide 11387, by RB Selander" [green label]; "*Holcocera tartarella* Dietz, Cotype" [hand-written label], "*tartarella,* Det., RB Selander." 1 ♀, [USNM]. (7) "Plummer's [sic] I[sland] M[arylan]d, Jun[e]/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]. 1 ♂, [USNM]. One syntype is lost.

sagitella (Dietz 1910:9), *Blastobasis*

Holotype ♂. "Hazleton P[ennsylvani]a, El[ectric] L[igh]t, 8[August]/2/[18]98"; "Type" [red label]; "Type 2964" [red label]; "*B*[*lastobasis*] *sagitella* Dietz, Type" [hand-written label]; "D Adamski ♂ genitalia slide 2046" [green label] (specimen is missing right pair of wings), [MCZ].

inclusa (Dietz 1910:51), *Holcocera,* **N. SYN.**

Holotype ♂. "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/20/[19]04"; "Type" [red label]; "WG Dietz Coll[ection]", "Type 2943" [red label]; "D Adamski ♂ genitalia slide 2103" [green label]; "*H*[*olcocera*] *inclusa* Dietz" [hand-written

label] (specimen is missing right pair of wings), [MCZ].

simplicella (Dietz 1910:9), *Blastobasis,* var. *Blastobasis plummerella* Dietz, **N. COMB., N. STA.**

Holotype ♂. "Iowa City I[ow]a, V-[May]/28/1899"; "Type" [red label]; "WG Dietz Coll[ection]"; "Type 2963" [red label], "*B*[*lastobasis*] *plummerella,* var. *simplicella* Dietz"; "D Adamski ♂ genitalia slide 2045" [green label], (specimen originally misidentified as female), [MCZ].

distinctella (Dietz 1910:10), *Blastobasis,* **N. SYN.**

Holotype ♂. "21469" [hand written in pencil]; "Type" [red label]; "*Blastobasis* n. sp. Slide, AB/1908" [hand-written label]; "*B*[*lastobasis*] *distinctella* Dietz, Type" [hand-written label]; "USNM ♀ genitalia slide 80988, DA 2418" [green label] (specimen with head in gelatin capsule), [USNM].

coenomorpha (Meyrick 1931:177), *Blastobasis,* **N. SYN.**

Lectotype designated by Clarke (1963): ♂, "Lectotype" [disc label] "Toronto, Canada, Parish, 16-22"; "*Blastobasis coenomorpha* Meyr., E. Meyrick det., in Meyrick Coll[ection]"; "BM ♂ genitalia slide 8094"; [BMNH].

Paralectotypes. Seven paralectotypes in BMNH.

differtella (McDunnough 1961:6), *Blastobasoides,* **N. SYN.**

Holotype ♂. "White Point Beach, Queens Co[unty], N[ova] S[cotia], 28/VI-[June]/1953, J McDunnough"; "Slide no. *Blas*[*tobasoides*], 2e♂"; "Holotype, *Blastobasoides differtella* McD, Type no. 7765" [red label], [CNC]. Four paratypes in CNC.

spoliatella (Dietz 1910:53), *Holcocera,* var. *Holcocera messelinella* Dietz, **N. STA.**

Lectotype here designated: ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/11/[19]06"; "cotype" [red label], "WG Dietz Coll[ection"; "Type 2946" [red label]; "D Adamski ♂ genitalia slide 2117" [green label]; "var *spoliatella* Dietz" [hand-written label], [MCZ].

Paralectotypes 2 ♂. (1) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, VIII-[August]/1/[19]07"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2946" [red label]; "D Adamski ♂ genitalia slide 2118" [green label]. 1 ♂, [MCZ]. (2) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, [illegible]/4/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2946" [red label]; "D Adamski ♂ genitalia slide 2119" [green label]. 1 ♂, [MCZ].

Other specimens.—Two specimens, which may be part of the original syntype series, are in MCZ. Their label data are as follows: ♂, "7[July]/15/[18[97], [illegible]" [white label written in red ink]; "Dr. Dietz, Hazleton Penn[sylvani]a"; "WG Dietz Coll[ection]"; (specimen is missing left pair of wings); ♂, "Montclair, N[ew] J[ersey], Trap, July 17, WD Kearfott [collector]"; "D Adamski ♂ genitalia slide 2120" [green label]. Two cotypes from Caldwell, New Jersey are apparently lost, and one specimen from Hazleton (PA) is of questionable type status.

spretella (Dietz 1910:58), *Holcocera*

Lectotype here designated: ♀, "Williams Ar[izona], 27/7[July]"; "HS Barber, Collector"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2931" [red label]; "D Adamski ♀ genitalia slide 2144" [green label], [MCZ].

Paralectotypes 2 ♂, 1 ♀. (1) "Williams Ar[izona], 11/6[June]"; "HS Barber"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2931" [red label]; "*H*[*olcocera*] *spretella* Dietz" [hand-written label] (specimen is missing abdomen). 1 ♂, [MCZ]. (2) "Williams Ar[izona], 10/VI-[June]"; "HS Barber"; "cotype" [red label], (specimen is missing abdomen, and

only the left pair of wings are spread). 1 ♂, [MCZ]. (3) "Phoenix Ariz[ona], 7-8/[illegible]"; "52"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2931" [red label] "D Adamski ♀ genitalia slide" [green label]. 1 ♀, [MCZ]. The paralectotype from Phoenix is not conspecific with the lectotype and other two paralectotypes.

texanella Walsingham 1907a:211, *Hypatopa,* **REV. STA.**

Holotype ♂. "Type" [disc label]; "Bosque Co[unty], Texas, 28/IV[April]/1876, Belfrage, 33087"; "Walsingham Collection, 1910-427"; "*Hypatopa texanella* Wlsm, Pr. US Nat. Mus. 33, p. 211 (1907), Type ♂" [hand-written label]; "BM ♂ genitalia slide 28083", [BMNH].

Paratypes. Six paratypes in BMNH; two paratypes in USNM, all from the same locality.

simulella (Dietz 1910:52), *Holcocera,* **N. SYN.**

Lectotype here designated: ♀, "Williams Ar[izona], 17/7[July]"; "HS Barber Collector"; "cotype" [red label], "♀ genitalia on slide no. 682, RB Selander"; "*simulella*" [hand written with pencil]; "USNM genitalia slide 11102, by RB Selander" [hand-written label], [USNM].

Paralectotypes 1 ♂, 2 ♀. (1) "Williams Ar[izona] 17/7[July]"; "HS Barber Collector"; "cotype" [red label], "*H*[*olcocera*] *simulella* Dietz" [hand-written label]; "USNM ♀ genitalia slide 81029, DA 2459" [green label] (specimen is missing right forewing, and has right hindwing in gelatin capsule). 1 ♀, [USNM] (2) "Fedora [Texas], 4[April]/1/[18]97" [white label with red handwriting], "cotype" [red label]; "WG Dietz Coll[ection"; "Type 2944" [red label]; "D Adamski ♀ genitalia slide 2143" [green label] (specimen is missing head, right pair of wings and left forewing). 1 ♀, [MCZ]. This specimen was probably misidentified as a male by Dietz. (3) "Williams Ar[izona], 17/7[July]"; "HS Barber Collector"; "cotype" [red label], WG Dietz Coll[ection]"; "Type 2944" [red label], "*H*[*olcocera*] *simulella* Dietz" [hand-written label] (specimen is missing left forewing) is in the MCZ. A female cotype collected by T Spalding from Stockton, Utah apparently is lost.

titanella McDunnough 1961:9, *Hypatopa*

Holotype ♂. "Pudsey P[oin]t, Cumb[erland] Co[unty], N[ova] S[cotia], 9/VII-[July]/1955, DC Ferguson"; "Slide no. Hol. 4a♂" [blue label]; "Holotype 7766, *Hypatopa titanella* McD." [red label] [CNC].

Paratypes. Four paratypes in CNC.

ursella (Walsingham 1907a:207), *Catacrypsis*

Holotype ♂. "Type" [disc label]; "Bear Creek, Shasta Co[unty], California, 27-28/VII[July]/1871, Wlsm, 90438"; "Walsingham Collection, 1910-427"; "*Catacrypsis ursella* Wlsm, Pr. US Nat. Mus. 33, p. 207 (1907), Type ♂" [hand-written label]; "BM ♂ genitalia slide 28082"; [BMNH].

vestaliella (Dietz 1910:63), *Holcocera,* **N. COMB.,** erroneously placed in *Holcocera* by Adamski and Brown (1989).

Lectotype here designated: ♂, "Plummer's [sic] I[sland], M[arylan]d, Jun[e]/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "♂ genitalia on slide no. 703, RB Selander"; "*vestaliella*" [hand written in pencil]; "USNM ♂ genitalia slide 11140, RB Selander" [green label] (specimen has left forewing in gelatin capsule), [USNM].

Paralectotypes 5 ♂. (1) "Plummer's [sic] I[sland] M[arylan]d, July 1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "*Hypatopa punctiferella* Cl[emens] = *subsenella* Z[eller]" [hand-written label]; "USNM ♂ genitalia slide 81039, DA 2469" [green label]; "*H*[*olcocera*] *vestal-*

iella Dietz" [hand-written label]. 1 ♂, [USNM]. (2) "July/5/[19]07"; "Cohasset Mass[achusetts]"; "Owen Bryant Collector"; "cotype" [red label]; "♂ genitalia on slide no. 704, RB Selander"; "USNM genitalia slide 11141, by RB Selander" [green label]. 1 ♂, [USNM]. (3) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/6/[19]04"; "cotype" [red label]; "WG Dietz Coll[ection"; "Type 2933" [red label] (specimen is missing head, left forewing and abdomen). 1 ♂, [MCZ]. (4) "Hazleton P[ennsylvani]a, VII[July]/1/[19]08"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2933" [red label] (specimen is missing left forewing and abdomen). 1 ♂, [MCZ]. (5) "Plummer's [sic] I[sland] M[arylan]d, July/1903"; "Aug[ust] Busck Collector"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2933" [red label]; "*H[olcocera] vestaliella* Dietz" [hand-written label] (specimen is missing abdomen). 1 ♂, [MCZ]. All syntypes are accounted for. Two additional male specimens from Plummer's [sic] Island, Maryland in MCZ collected by August Busck in 1922.

PIGRITIA Clemens 1860:172

DRYOPE Chambers 1874a:49, preocc. by Robineau-Desvoidy 1830:618
PLOIOPHORA Dietz 1900:102
EPIGRITIA Dietz 1900:110
PSEUDOPIGRITIA Dietz 1900:112
DRYOPERIA Coolidge 1909:112

arizonella Dietz 1900:109, *Pigritia*

Lectotype here designated: ♂, "Nogales Ariz[ona], 6[June]/6/[19]89"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2912" [red label]; "D Adamski ♂ genitalia slide 2169" [green label]; "*arizonella* Dietz" [hand-written label], [MCZ].

Paralectotype 1 ♀. "Huachuca Ariz[ona], 7[July]/3/[19]89"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2912" [red label]; "D Adamski ♀ genitalia slide 2170" [green label] (specimen is missing right pair of wings), [MCZ].

fidella (Dietz 1900:103), *Ploiophora*

Lectotype designated by Adamski and Brown (1989): ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/16/1900"; "[wing] slide 13" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2924" [red label]; "D Adamski ♂ genitalia slide 2162" [green label], [MCZ].

Paralectotypes 3 ♂, 2 ♀. (1) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/28/1900"; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2924" [red label]; "D Adamski ♀ genitalia slide 2164" [green label]. 1 ♀, [MCZ]. (2) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/2/1900"; "Type ♀ palpi" [hand-written label]; "Type" [red label]; "WG Dietz Coll[ection]"; Type 2924" [red label]; "D Adamski ♀ genitalia slide 2165" [green label]. 1 ♀, [MCZ]. (3) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/22/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2924" [red label], "*fidella* Dietz" [hand-written label]. 1 ♂, [MCZ]. (4) "Hazleton P[ennsylvani]a, 6[June]/25/1900, Light"; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2924" [red label]; "SEM left L[abial] palp, Adamski, 86" [hand-written label]. 1 ♂, [MCZ]. (5) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/13/[18]99"; "USNM Type 6136" [red label]; "USNM ♂ genitalia slide 80054, DA 2484" [green label]; "*Ploiophora fidella* D[ietz]" [hand-written label]. 1 ♂, [USNM]. Dietz (1900) did not specify number of syntypes in his description of this species.

laticapitella Clemens 1860:173, *Pigritia*

Holotype ♀. "210" [hand-written label]; "Type 7377, *Pigritia laticapitella* Clemens" [red label], [white Clemens ID label]; "D Adamski ♀ genitalia slide 2840" [green label]. Specimen has no right or left fore-

wings, [ANSP]. Holotype probably was collected in Easton, Pennsylvania.

ochreella Clemens 1863:126, *Pigritia,* N. SYN.

Holotype ♀. "211" [hand-written label]; "Type 7379, *Pigritia ochreella* Clemens" [red label], [white Clemens ID label]; "D Adamski ♀ genitalia slide 2842" [green label]. Specimen is missing right pair of wings and left forewing, [ANSP]. Holotype probably was collected in Easton, Pennsylvania.

ochreela Adamski & Brown 1989:25. *missp.*

aufugella (Zeller 1873:300), *Blastobasis?*

Holotype ♂. "Dallas Tex[as], Boll"; "Type 14978" [red label]; "*Blastobasis anfugella* Z[eller]" [hand written green label]; "*B*[*lastobasis*] *anfugella* Zell[er], 1873, p. 300" [hand-written label] (specimen is missing abdomen), [MCZ].

anfugella Dietz 1900:119, missp.

ampla (Dietz 1900:103), *Ploiophora,* N. SYN.

Lectotype here designated: ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/12/[18]97"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2923" [red label], "D Adamski ♂ genitalia slide 2159" [green label]; "*ampla* Dietz" [hand-written label], [MCZ].

Paralectotypes 3 ♂, 1 ♀. (1) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/27/1900"; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2923" [red label]; "D Adamski ♂ genitalia slide 2160" [green label]. 1 ♂, [MCZ]. (2) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/5/[18]99"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2923" [red label]; "D Adamski ♂ genitalia slide 2161" [green label]. 1 ♂, [MCZ]. (3) "6[June]/24/[18]97, [illegible]" white label with red handwriting]; "Dr. Dietz, Hazleton, Penn-[sylvani]a" "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2923" [red label] (specimen is missing abdomen and both hindwings). 1 ♀, [MCZ]. (4) "6-[June]/30/[18]97, El[ectric] l[ight]" [white label with red handwriting]; "Dr. Dietz, Hazleton Penn[sylvani]a"; "USNM Type 6135" [red label], "USNM ♂ genitalia slide 81041, DA 2471" [green label], "*Ploiophora ampla* D[ietz]" [hand-written label]. 1 ♂, [USNM]. Dietz (1900) did not specify the number of syntypes in his description of this species.

confusella Dietz 1900:104, *Pigritia,* N. SYN.

Lectotype here designated: ♂, "6[June]/9/[18]96, El[ectric] l[ight]" [white label with red handwriting]; "Dr. Dietz, Hazleton Penn[sylvani]a"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2925" [red label] "D Adamski ♂ genitalia slide 2173" [green label], [MCZ].

Paralectotypes 4 ♀. (1) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/28/[18]98"; "Type ♀ palpi" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2925" [red label]; "D Adamski ♀ genitalia slide 2172" [green label]; "*confusella* Dietz" [hand-written label] (specimen is missing right hindwing and distal third of the left forewing). 1 ♀, [MCZ]. (2) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, [illegible]/18/[18]99"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2925" [red label]; "D Adamski ♀ genitalia slide 2174" [green label] (specimen is missing right forewing). 1 ♀, [MCZ]. (3) "Hazleton P[ennsylvani]a, [illegible]/20/1900, Light"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2921" [red label] (specimen is not dissected). 1 ♀, [MCZ]. (4) "Montclair N[ew] J[ersey], Trap, June 20, WD Kearfott"; "USNM Type 6131" [red label]; "USNM ♀ genitalia slide 81046, DA 2476" [green label]; "*Pigritia confusella* Dietz, Cotype"

[hand-written label] (specimen is missing right forewing and has metathorax and hindwings in a gelatin capsule). 1 ♀, [USNM]. An additional female specimen from New Jersey may be part of the syntype series. Its label data are as follows: ♀, "Montclair N[ew] J[ersey], Trap July 17, WD Kearfott"; "D Adamski ♀ genitalia slide 2175" [green label]. Dietz (1900) did not specify the number of syntypes in his description of this species.

purpurella Dietz 1900:105, *Pigritia,* N. SYN.

Lectotype here designated: ♀, "Hazleton P[ennsylvania], 6[June]/15/1900, [illegible]"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2926" [red label]; "D Adamski ♀ genitalia slide 2189" [green label], [MCZ].

Paralectotypes 2 ♀. (1) "6[June]/14/[18]99"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2926" [red label]; "D Adamski ♀ genitalia slide 2188" [green label]; "*purpurella* Dietz" [hand-written label]. 1 ♀, [MCZ]. (2) "6[June]/14/[18]97, [illegible]" [white label with red handwriting]; "Dr. Dietz, Hazleton, Penn[sylvani]a"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2926" [red label]; "D Adamski ♀ genitalia slide 2190" [green label]. 1 ♀, [MCZ]. All syntypes are accounted for.

basilarella Dietz 1900:105, *Pigritia,* N. SYN.

Lectotype here designated: ♀, "6[June]/25/[18] 99" [hand-written label]; "Lawrence, Kansas" [hand-written label], "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2928" [red label]; "D Adamski ♀ genitalia slide 2171" [green label] (specimen is missing left forewing), [MCZ].

Paralectotypes 1 ♀, 1 Sex?. (1) "Iowa City, Wickham, VI[June]/23/[18]98"; "20" [red label]; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2928" [red label] (specimen is missing abdomen, left pair of wings, and right hindwing). (1 Sex?). (2) "7[July]/2/[18]97, El[ectric] l[ight]" [white label with red handwriting]; "Dr. Dietz, Hazleton Penn[sylvani]a"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2928" [red label]; "*basilarella* Dietz" [hand-written label] (specimen is missing abdomen). 1 ♂, [MCZ]. All original syntypes are accounted for.

basilorella Dietz 1900:104, 119, 120, missp.

mediofasciella Dietz 1900:107, *Pigritia,* N. SYN.

Holotype ♀. "7[July]/10/[18]97, El[ectric] l[ight]" [white label with red handwriting]; "Dr. Dietz, Hazleton, Penn[sylvani]a"; "18" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2927" [red label]; "D Adamski ♀ genitalia slide 2179" [green label]; "*mediofasciella* Dietz" [hand-written label], [MCZ].

ornatella Dietz 1900:107, *Pigritia,* N. SYN.

Lectotype here designated: ♀, "Hazleton P[ennsylvani]a, 6[June]/15/[19]89"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2929" [red label]; "D Adamski ♀ genitalia slide 2184" [green label] (specimen is missing right forewing), [MCZ].

Paralectotypes 1 ♂, 6 ♀. (1) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/9/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2929" [red label]; "D Adamski ♀ genitalia slide 2182" [green label]. 1 ♀, [MCZ]. (2) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/2/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2929" [red label], "D Adamski ♀ genitalia slide 2183" [green label]. 1 ♀, [MCZ]. (3) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, [May]/30/1900"; "cotype" [red label]; "WG Dietz

Collection]"; "Type 2929" [red label]; "D Adamski ♂ genitalia slide 2185" [green label] (specimen is missing right pair of wings). 1 ♂, [MCZ]. (4) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6 [June]/25/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2929" [red label]; "D Adamski ♀ genitalia slide 2186" [green label]. 1 ♀, [MCZ]. (5) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, [illegible]/7/[18]99"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2929" [red label], "*ornatella* Dietz" [hand-written label] (specimen is missing abdomen). 1 ♀, [MCZ]. (6) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/5/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2929" [red label] (specimen is missing abdomen). 1 ♀, [MCZ]. (7) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/11/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2929" [red label] (specimen is not dissected). 1 ♀, [MCZ]. Dietz (1900) did not specify the number of syntypes in his description of this species.

angustipennella Dietz 1900:108, *Pigritia,* **N. SYN.**

Lectotype here designated: ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/28/1900"; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2930" [red label]; "D Adamski ♂ genitalia slide 2166" [green label], [MCZ].

Paralectotypes 3 ♂, 2 ♀. (1) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, [illegible]/26/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2930" [red label]; "D Adamski ♂ genitalia slide 2167" [green label]. 1 ♂, [MCZ]. (2) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/25/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2930" [red label], "D Adamski ♀ genitalia slide 2168" [green label]. 1 ♀, [MCZ]. (3) "Hazleton P[ennsylvani]a, 6[June]/22/1900, on Locust"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2930" [red label] (specimen is not dissected). 1 ♀, [MCZ]. (4) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/28/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2930" [red label]; "*angustipennella* Dietz" [hand-written label] (specimen is missing abdomen). 1 ♂, [MCZ]. (5) "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/25/1900"; "USNM Type 6137" [red label]; "USNM ♂ genitalia slide 81043, DA 2473" [green label]; "*Pigritia angustipennella* D[ietz]" [hand-written label]. 1 ♂, [USNM]. Dietz (1900) did not specify the number of syntypes in his description of this species.

tristella Dietz 1900:108, *Pigritia,* **N. SYN.**

Lectotype here designated: ♀, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/2[illegible]/1900"; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2911" [red label]; "D Adamski ♀ genitalia slide 2194" [green label]; "*tristella* Dietz" [hand-written label] (specimen has metathorax and hindwings in gelatin capsule), [MCZ].

Paralectotype 1 ♀. "Hazleton, P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/22/1900"; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2911" [red label]; "D Adamski ♀ genitalia slide 2193" [green label], [MCZ]. One additional specimen in USNM: ♀, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/28/1900"; "USNM Type 6132" [red label]; "USNM ♀ genitalia slide 81051, DA 2481" [green label]; "*Pigritia tristella* Dietz, Cotype" [hand-written label] (specimen probably is not part of the syntype series). All original syntypes are accounted for.

obscurella Dietz 1900:110, *Pigritia,* **N. SYN.**

Lectotype here designated: ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/6/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2914" [red label]; "D

Adamski ♂ genitalia slide 2180" [green label], [MCZ].

Paralectotype 1 ♀. "6[June]/28/[18]97" [white label with red handwriting]; "Dr. Dietz, Hazleton Penn[sylvani]a"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2914" [red label]; "*obscurella* Dietz" [hand-written label]. [MCZ]. One female specimen from California in USNM with "USNM Type 474" label and one male specimen from Essex County Park, New Jersey with a hand-written cotype label by Dietz probably are not part of the syntype series. All original syntypes are accounted for.

dorsomaculella (Dietz 1900:112), *Pseudopigritia,* **N. SYN.**

Lectotype designated by Adamski and Brown (1989): ♀, "7[July]/10/[18]97, El[ectric] l[igh]t" [white label with red handwriting]; "Dr Dietz, Hazleton, Penn[sylvani]a"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2917" [red label] (specimen is missing abdomen), [MCZ].

Paralectotype 1 ♂. "Hazleton P[ennsylvani]a, El[ectric] l[igh]t"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2917" [red label]; "*dorsomaculella* Dietz" [hand-written label] (specimen is missing abdomen), [MCZ]. All syntypes are accounted for.

equitella (Dietz 1900:112), *Pseudopigritia,* **N. SYN.**

Lectotype here designated: ♀, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/18/[18]99"; "cotype" [red label], "WG Dietz Coll[ection]"; "Type 2918" [red label]; "D Adamski ♀ genitalia slide 2204" [green label], [MCZ].

Paraletotypes 3 ♀. (1) "7[July]/8/[18]96, El[ectric] l[ight]" [white label with red handwriting]; "Dr. Dietz, Hazleton, Penn[sylvani]a"; "[wing] slide 5" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection"; "Type 2918" [red label]; "*equitella* Dietz" [hand-written label]. 1 ♀, [MCZ]. (2) "Hazleton P[ennsylvani]a, 6[June]/26/[18]99"; "[wing] slide 16" [hand-written label]; "cotype" [red label], "WG Dietz Coll[ection]; "Type 2918" [red label]; "D Adamski ♀ genitalia slide 2205" [green label]. 1 ♀, [MCZ]. (3) "7[July]/8/[18]97, [illegible]" [white label with red handwriting]; "Dr, Dietz, Hazleton Penn-[sylvani]a"; "USNM Type 6134" [red label]; "USNM ♀ genitalia slide 81055, DA 2485" [green label]; "*Pseudopigritia equitella* D[ietz]." 1 ♀, MCZ. Dietz (1900) did not specify the number of syntypes in his description of this species.

fraternella (Dietz 1900:113), *Pseudopigritia,* **N. SYN.**

Holotype ♂. "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/14/[18]98"; "Type" [red label]; "WG Dietz Coll[ection]"; "Type 2919" [red label]; "*fraternella* Dietz" [hand-written label]; "D Adamski ♂ genitalia slide 2207" [green label], [MCZ].

argyreella (Dietz 1900:113), *Pseudopigritia,* **N. SYN.**

Holotype ♂. "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/2/1900"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2920" [red label]; "*argyreella* Dietz" [hand-written label]; "D Adamski ♂ genitalia slide 2201" [green label], [MCZ].

argyreela missp., Adamski & Brown (1989:25)

occidentella (Dietz 1900:115), *Dryope,* **N. SYN.**

Holotype ♀. "Kaweah, Cal[ifornia], [18]98"; "Type" [red label]; "Type 11300" [red label]; "*occidentella* Dietz" [hand-written label] (specimen is missing abdomen and left forewing), [MCZ].

erratella (Dietz 1910:4), *Dryope,* **N. SYN.**

Holotype ♂. "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/19/1900"; "*erratella* Dietz" [hand-written label]; "MCZ Holotype 34660" [red label, affixed to pin by Adamski]; "D Adamski ♂ genitalia slide 2237" [green label], [MCZ]. Dietz (1900) did not specify the number of syntypes in proposing the name *erratella,* consequently, the exact number is not known. Because only one specimen has a hand-written label "*erratella* Dietz"; we can be reasonably sure that this specimen was either the only specimen representing this species, or one specimen of a series that we cannot identify.

murtfeldtella (Chambers 1874a:50), *Dryope*

Lectotype here designated: ♂, "Type 1437" [red label], "Kentucky"; "Peab[ody] Acad[emy]"; "51" [hand-written label], "*murtfeldtella* Ch[am]b[ers]" [hand-written label]; "D Adamski ♂ genitalia slide 2234" [green label], [MCZ].

Paralectotypes 7 ♂, 1 ♀, 6 Sex?. (1) "Type 1437" [red label], "Kentucky, Chambers"; "104" [hand-written label]; "D Adamski ♀ genitalia slide 2235" [green label]; "*murtfeldtella*" [hand-written label] (specimen is in a gelatin capsule). 1 ♀, [MCZ]. (2) "Type 1437" [red label]; "Kentucky, Chambers"; "*Dryope murtfeldtella* Cham[bers]" [hand-written label] (only hindwings attached to cork block remain of specimen). (Sex?), [MCZ]. (3) "Type 1437" [red label]; "Kentucky, Chambers"; "104" [hand-written label]; "*murtfeldtella*" [hand-written label] (specimen not dissected). (Sex?), [MCZ]. (4) "Type 1437" [red label]; "Kentucky, Chambers"; "*Dryope murtfeldtella* Cham[bers]" [hand-written label] (specimen is missing abdomen, and is not spread). (Sex?), [MCZ]. (5) "Type 1437" [red label], "Kentucky, Chambers"; "*Dryope murtfeldtella* Cham[bers]" [hand-written label] (specimen is missing abdomen, and is not spread). (Sex?), [MCZ]. (6) "Type 1437" [red label]; "Kentucky, Chambers"; "*Dryope murtfeldtella* Cham[bers] [hand-written label] (specimen is missing head and abdomen, and is not spread). (Sex?), [MCZ]. (7–8) "Type 1437" [red label], "Kentucky, Chambers"; "*Dryope murtfeldtella* Cham[bers]" [hand-written label] (specimens are missing abdomens and are not spread). (2Sex?), [MCZ]. (9) "Type 1437" [red label]; "Kentucky, Chambers"; "*Dryope murtfeldtella* Cham[bers]" [hand-written label] (specimen is not spread). 1 ♂, [MCZ]. (10) "Type 1437" [red label]; "Kentucky"; "Peab[ody] Acad[emy]"; "15" [hand-written label]; "*murtfeldtella*" [hand-written label]. 1 ♂, [MCZ]. (11) "Type 1437" [red label]; "Kentucky, Chambers"; "104" [hand-written label]; "*murtfeldtella*" [hand-written label] (specimen is missing abdomen). 1 ♂, [MCZ]. (12) "Kentucky, Chambers"; (specimen is not dissected). 1 ♂, [MCZ]. (13–14) "Kentucky, Chambers"; (both specimens are double mounted on same block; one specimen not dissected, and the other specimen with abdomen in gelatin vial). 2 ♂, [MCZ]. Chambers (1874) did not specify the number of syntypes in his description of this species.

luteopulvella (Chambers 1875b:73), *Dryope,* **N. SYN.**

Holotype ♀. "Type 1438" [red label]; "Kentucky"; "120" [hand-written label]; "*luteopulvella* Ch[am]b[ers]" [hand-written label]; "D Adamski ♀ genitalia slide 2178" [green label], [MCZ].

spoliatella Dietz 1900:110, *Pigritia,* **N. SYN.**

Lectotype here designated: ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/2[illegible]/1900"; "Slide 17" [hand-written label]; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2913" [red label]; "*spoliatella* Dietz" [hand-written label] (specimen is missing right forewing), [MCZ].

Paralectotype 1 ♀. "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/14/[18]98"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2913" [red label] (specimen is missing abdomen and left forewing), [MCZ]. Paralectotype female probably was misidentified as male by Dietz (1900).

pallidotinctella (Dietz 1900:111), *Epigritia,* **N. SYN.**

Lectotype designated by Adamski and Brown (1989): ♂, "7[July]/12/[18]95, El[ectric] light" [white label with red handwriting]; "Dr. Dietz, Hazleton Penn[sylvani]a"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2915" [red label], "*pallidotinctella* Dietz" [hand-written label] (specimen is missing abdomen), [MCZ].

Paralectotype 1 ♂. "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 7[July]/29/[18]99"; "cotype" [red label]; "WG Dietz Coll[ection]"; "Type 2915" [red label] (specimen is missing right pair of wings), [MCZ]. One syntype is lost.

tenebrella (Dietz 1900:116), *Dryope,* **N. SYN.**

Lectotype here designated: ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/7/[18]99"; "cotype" [red label], "Type 14220" [red label]; "*tenebrella* Dietz" [hand-written label]; "D Adamski ♂ genitalia slide 2233" [green label], [MCZ].

Paralectotype 1 ♂. "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/7/[18]98"; "cotype" [red label]; "Type 14220" [red label] (specimen is missing abdomen), [MCZ]. One syntype is lost.

minnicella (Dietz 1900:116), *Dryope,* **N. SYN.**

Lectotype here designated: ♂, "Forsyth G[eorgi]a, [18]98"; "cotype" [red label]; "Type 14221" [red label]; "D Adamski ♂ genitalia slide 2229" [green label], [MCZ].

Paralectotypes 4 ♂. (1) "Forsyth G[eorgi]a, [18]98"; "cotype" [red label]; "Type 14221" [red label]; "D Adamski ♂ genitalia slide 2230" [green label]. 1 ♂, [MCZ]. (2); "Forsyth G[eorgi]a, [18]98"; "cotype" [red label]; "Type 14221" [red label]; "*minnicella* Dietz" [hand-written label] (specimen is not dissected). 1 ♂, [MCZ]. (3) "Forsyth G[eorgi]a, [18]98"; "cotype" [red label]; "Type 14221" [red label] (specimen is missing left forewing and is not dissected). 1 ♂, [MCZ]. (4) "Forsyth G[eorgi]a, [18]98"; (specimen is not dissected). 1 ♂, [MCZ]. All syntypes are accounted for.

minnieella Dietz 1900:120 missp.

grisella (Dietz 1900:116), *Dryope,* **N. SYN.**

Lectotype here designated: ♂, "Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/7/[18]99"; "cotype" [red label], "Type 14225" [red label]; "D Adamski ♂ genitalia slide 2218" [green label]; "*grisella* Dietz" [hand-written label], [MCZ].

Paralectotypes 2 ♂. (1) "S[ain]t Louis M[iss]o[uri], 6[June]/2–5/9[illegible]"; "cotype" [red label]; "D Adamski ♂ genitalia slide 2231" [green label]. 1 ♂, [MCZ]. (2) "743"; "2/IV[April]" [hand-written label]; "From Boll Texas"; "Collection CV Riley"; "*Pigritia* sp., (= 748), Walsingh[am], Aug[ust]/[18]91" [hand-written label]; "*Dryope grisella* Dietz" [hand-written label. 1 ♂, [MCZ]. Two additional specimens from Saint Louis, Missouri without cotype labels are in the MCZ: ♂, "D Adamski ♂ genitalia slide 2223" [green label]; ♂, "D Adamski ♂ genitalia slide 2224" [green label]. Dietz (1900) did not specify the number of syntypes in his description of this species. The syntype(s) from South Dakota are lost.

fuscosuffusella (Dietz 1900:117), *Dryope,* **N. SYN.**

Lectotype here designated: ♂, "S[ain]t

Louis M[iss]o[uri], 5[May]/26/[18]98''; ''cotype'' [red label]; ''Type 14222'' [red label]; ''D Adamski ♂ genitalia slide 2215'' [green label], [MCZ].

Paralectotype 1 ♀. ''S[ain]t Louis M[iss]o[uri], 8[August]/12/[18]98''; ''cotype'' [red label]; ''Type 14222'' [red label]; ''D Adamski ♀ genitalia slide 2216'' [green label], ''*fuscosuffusella* Dietz'' [hand-written label], [MCZ]. All original syntypes are accounted for.

canariella (Dietz 1900:118), *Dryope,* **N. SYN.**

Holotype ♂. ''Occidental'' [white label with red handwriting], ''[Sonoma] Cal[ifornia]''; ''2719, Wlsm, 1898''; ''Type 14226'' [red label]; ''*Pigritia ochreella* Clem[ens]?, Wlsm., Named by WLSM'' [hand-written label]; ''D Adamski ♂ genitalia slide 2212'' [green label], [MCZ].

discopunctella (Dietz 1900:118), *Dryope,* **N. SYN.**

Holotype ♀. ''Hazleton P[ennsylvani]a, El[ectric] l[igh]t, 6[June]/2/[18]99''; ''Type'' [red label]; ''Type 14223'' [red label]; ''*discopunctella* Dietz'' [hand-written label]; ''D Adamski ♀ genitalia slide 2213'' [green label], [MCZ].

fenyesella (Dietz 1900:119), *Dryope,* **N. SYN.**

Holotype ♂. ''Pomona. [18]95'' [white label with red handwriting]; ''Type'' [red label]; ''Type 14224'' [red label], ''*Fenyesella* Dietz'' [hand-written label]; ''D Adamski ♂ genitalia slide 2214'' [green label] (specimen with left forewing in gelatin capsule), [MCZ].

ochrocomella Clemens 1863:126, *Pigritia*

Holotype ♂. ''209'' [hand-written label]; ''Type 7378, *Pigritia ochrocomella* Clemens'' [red label], [white Clemens ID label]; ''D Adamski ♂ genitalia slide 2841'' [green label]. Specimen is missing left pair of wings), [ANSP]. Holotype was probably collected in Easton, Pennsylvania.

ochroeomella Dietz 1900:117, missp.

heidemannella (Dietz 1900:111), *Epigritia*

Lectotype here designated: ♂, ''Sulphur Sp[rings], Bedford Co[unty], P[ennsylvani]a, 1900'' [hand-written label]; ''USNM Type 6133'' [red label]; ''USNM ♂ genitalia slide 81053, DA 2483'' [green label]; ''*Epigritia Heidmannella* Dietz'' [hand-written label], [USNM].

Paralectotypes 2 ♀. (1) ''Sulphur Springs, Bedford Co[unty], P[ennsylvani]a, 1900'' [hand-written label], ''cotype'' [red label]; ''WG Dietz Coll[ection]''; ''Type 2916'' [red label]; ''D Adamski ♀ genitalia slide 2208'' [green label]. 1 ♀, [MCZ]. (2) same label data as above. Specimen is missing abdomen, left hindwing, and right forewing. 1 ♀, [MCZ]. Four syntypes are lost.

MASTEMA Adamski, *in* Adamski and Brown 1989:22

occidentalis Adamski, *in* Adamski and Brown 1989:22, *Mastema*

Holotype ♂. ''Madera Canyon, 5600′, Santa Rita M[oun]t[ai]ns, Ariz[ona], September 2, 1959, RW Hodges''; ''USNM ♂ genitalia slide 81472, DA 3005'' [green label]. Ten paratypes in USNM.

TAXONOMIC SUMMARY

BLASTOBASINAE, Meyrick 1894:22

HOLCOCERINI Adamski, *in* Adamski and Brown 1989:16, **NEW STATUS**

ASAPHOCRITA Meyrick 1931:78

HOLCOCERINA McDunnough 1961: 14.

aphidiella (Walsingham 1907a:205), *Holcocera,* **N. COMB.**

dives (Dietz 1910:26), *Holcocera,* **N. SYN.**

basipallidella (Dietz 1910:27), *Holcocera dives,* var., **N. SYN.**

confluentella (Dietz 1910:36), *Holcocera,* **N. SYN., N. COMB.**
simplicis (McDunnough 1961:17), *Holcocerina,* **N. SYN., N. COMB.**
busckiella (Dietz 1910:36), *Holcocera*
estriatella (Dietz 1910:28), *Holcocera*
simuloides (McDunnough 1961:16), *Holcocerina,* **N. SYN.**
fuscopurpurella (Dietz 1910:9), *Blastobasis plummerella* var., **N. STA.**
irenica (Walsingham 1907a:208), *Catacrypsis,* **N. COMB.**
plagiatella (Dietz 1910:40), *Holcocera*
plummerella (Dietz 1910:8), *Blastobasis*
protypica Meyrick 1931:178, *Asaphocrita*
sciaphilella (Zeller 1873:295), *Blastobasis*
stygna (Walsingham 1907a:207), *Catacrypsis,* **N. SYN., N. COMB.**
triangularisella (Chambers 1875a:256), *Holcocera*

HOLCOCERA Clemens 1863:121

CYNOTES Walsingham 1907b:210
EUBOLEPIA Dietz 1910:67
HOLOCERA Dietz 1910:33, missp.

anomalella (Dietz 1910:68), *Eubolepia*
chalcofrontella Clemens 1863:122, *Holcocera*
purpurocomella Clemens 1863:122, *Holcocera,* **N. SYN.**
gilbociliella Clemens 1863:122, *Holcocera,* **N. SYN.**
gibbociliella Forbes 1923:310; Hodges 1983:15; Adamski and Brown 1989: 24, missp.
quisquiliella (Zeller 1873:298), *Blastobasis chalcofrontella* var.
livorella (Zeller 1873:299), *Blastobasis,* **N. SYN.**
maligemmella (Murtfeldt 1898:5), *Nothris?,* **N. SYN.**
ochrocephala Dietz 1910:31, *Holcocera,* **N. SYN.**
minorella Dietz 1910:34, *Holcocera chalcofrontella var.*
fumerella Dietz 1910:35, *Holcocera chalcofrontella,* var.
reductella Dietz 1910:45, *Holcocera funebra,* var., **N. SYN., REV. COMB.**
coccivorella (Chambers 1880:244), *Blastobasis*
crassicornella Dietz 1910:32, *Holcocera*
eriobotryae (Busck 1915:85), *Blastobasis,* **N. SYN.**
gargantuella (Heinrich 1920:69), *Eubolepia*
gigantella Chambers 1876:219, *Holcocera*
guilandinae (Busck 1900a:234), *Blastobasis*
iceryaeella (Riley 1887:484), *Blastobasis*
phenococci Braun 1927:118, *Holcocera,* **N. SYN.**
immaculella McDunnough 1930:269, *Holcocera*
panurgella Heinrich 1920:71, *Holcocera*
paradoxa Powell 1976:224, *Holcocera*
villella (Busck 1900b:238), *Triclonella,* described in Oecophoridae, name omitted by Hodges (1983) and Adamski and Brown (1989)
vilella Dietz 1910:6, missp.
augusti Heinrich 1920:70, *Holcocera,* **N. SYN.**

CALOSIMA Dietz 1910:21

albapenella (Chambers 1875b:11), *Butalis,* transferred from *Scythris,* Scythrididae, Adamski and Brown (1989)
citricolella (Chambers 1880:206), *Blastobasis,* **N. SYN., N. COMB.**
nana (Dietz 1910:48), *Holcocera,* **N. SYN., N. COMB.**
argyrosplendella Dietz 1910:22, *Calosima*
dianella Dietz 1910:22
lepidophaga (Clarke 1960:115), *Holcocera,* **N. SYN.**
elyella (Dietz 1910:49), *Holcocera*
lucidella Adamski, *in* Adamski and Brown 1989
melanostriatella (Dietz 1910:66), *Holcocera*
melonostriatella Dietz 1910:66, missp.

BLASTOBASINI Meyrick 1894:22, **REVISED STATUS**

BLASTOBASIS Zeller 1855:171
EPISTETUS Walsingham 1894:552
VALENTINIA Walsingham 1907a:200
ZENODOCHIUM Walsingham 1908a:52
PROSTHESIS Walsingham 1908b:953
EURESIA Dietz 1910:20
BLASTORASIS Dietz 1910:69 missp.

confamulella (Heinrich 1921:818), *Holcocera*
confectella (Zeller 1873:303), *Hypatima*
floridella (Dietz 1910:17), *Valentinia*
glandulella (Riley 1871:118), *Gelechia*
modestella (Clemens 1863:122), N. SYN., *Holcocera,* pending ruling of ICZN to suppress a senior synonym.
nubilella Zeller 1873:297, *Blastobasis*
nothrotes (Walsingham 1907a:202), *Valentinia*
pulchella (Dietz 1910:20), *Euresia*
pulebella Dietz 1910:20, missp.
maritimella McDunnough 1961:5, *Blastobasis* N. SYN.
quaintancella (Dietz 1910:15), *Valentinia*
repartella (Dietz 1910:19), *Valentinia*
retectella Zeller 1873:297, *Blastobasis*
fractilinea Zeller 1873:298, *Blastobasis,* N. SYN.
yuccaecolella Dietz 1910:7, *Blastobasis*

HYPATOPA Walsingham 1907a:211
PROSODICA Walsingham 1907a:200
CATACRYPSIS Walsingham 1907a:206
CATACRYPRIS Dietz 1910:2 missp.
PRORODICA Dietz 1910:23 missp.
BLASTOBASOIDES McDunnough 1961:6

annulipes (Dietz 1910:58), N. STA., *Holcocera,* var. of *Holcocera crescentella* Dietz
boreasella (Dietz 1910:47), *Holcocera*
crescentella (Dietz 1910:57), *Holcocera*
fluxella (Zeller 1873:301), *Blastobasis*(?)
zelleriella (Dietz 1910:62), *Holcocera,* N. SYN.
annectella (Dietz 1910:63), *Holcocera,* var. of *zelleriella* Dietz N. SYN.
pusilla (Dietz 1910:65), *Holcocera,* N. SYN.
funebra (Dietz 1910:44), *Holcocera*
hulstella (Dietz 1910:7), *Blastobasis*
illibella (Dietz 1910:57), *Holcocera*
inconspicua (Walsingham 1907a:208), *Catacrypsis*
insulatella (Dietz 1910:50), *Holcocera*
rufopunctella (Dietz 1910:65), *Holcocera,* N. SYN.
interpunctella (Dietz 1910:67), *Holcocera*
messelinella (Dietz 1910:52), *Holcocera*
morrisoni (Walsingham 1907a:209), *Catacrypsis*
nigrostriata (Walsingham 1907a:204), *Holcocera*
nigristriata Dietz 1910:29, missp.
nucella (Walsingham 1907a:206), *Catacrypsis*
punctiferella (Clemens 1863:119), *Gelechia*
subsenella (Zeller 1873:302), *Hypatima,* var. *Holcocera punctiferella* Clemens
clemensella (Chambers 1874b:246), *Holcocera,* N. SYN.
tartarella (Dietz 1910:64), *Holcocera,* N. SYN.
sagitella (Dietz 1910:9), *Blastobasis*
inclusa (Dietz 1910:51), *Holcocera,* N. SYN.
simplicella (Dietz 1910:9), *Blastobasis,* var. *Blastobasis plummerella* Dietz, N. COMB., N. STA.
distinctella (Dietz 1910:10), *Blastobasis,* N. SYN.
coenomorpha (Meyrick 1931:177), *Blastobasis,* N. SYN.
differtella (McDunnough 1961:6), *Blastobasoides,* N. SYN.
spoliatella (Dietz 1910:53), *Holocera,* var. *Holcocera messelinella* Dietz, N. STA.
spretella (Dietz 1910:58), *Holcocera*
texanella Walsingham 1907a:211, *Hypatopa,* REV. STA.
simulella (Dietz, 1910:52) *Holcocera,* N. SYN.
titanella McDunnough 1961:9, *Hypatopa*
ursella (Walsingham 1907a:207), *Catacrypsis*

vestaliella (Dietz 1910:63), *Holcocera,* **N. COMB.,** erroneously placed in *Holcocera* by Adamski and Brown (1989).

PIGRITIA Clemens 1860:172

DRYOPE Chambers 1874a:49, preocc. by Robineau-Desvoidy 1830:618
PLOIOPHORA Dietz 1900:102
PLOEOPHORA Dietz 1900: missp.
EPIGRITIA Dietz 1900:110
PSEUDOPIGRITIA Dietz 1900:112
DRYOPERIA Coolidge 1909:112

arizonella Dietz 1900:109, *Pigritia*
fidella (Dietz 1900:103), *Ploiophora*
laticapitella Clemens 1860:173, *Pigritia*
ochreella Clemens 1863:126, *Pigritia,* **N. SYN.**
ochreela Adamski & Brown 1989:25. *missp.*
aufugella (Zeller 1873:300), *Blastobasis?*
anfugella Dietz 1900:119, missp.
ampla (Dietz 1900:103), *Ploiophora,* **N. SYN.**
confusella Dietz 1900:104, *Pigritia,* **N. SYN.**
purpurella Dietz 1900:105, *Pigritia,* **N. SYN.**
basilarella Dietz 1900:105, *Pigritia,* **N. SYN.**
basilorella Dietz 1900:104, 119, 120, missp.
mediofasciella Dietz 1900:107, *Pigritia,* **N. SYN.**
ornatella Dietz 1900:107, *Pigritia,* **N. SYN.**
angustipennella Dietz 1900:108, *Pigritia,* **N. SYN.**
tristella Dietz 1900:108, *Pigritia,* **N. SYN.**
obscurella Dietz 1900:110, *Pigritia,* **N. SYN.**
dorsomaculella (Dietz 1900:112), *Pseudopigritia,* **N. SYN.**
equitella (Dietz 1900:112), *Pseudopigritia,* **N. SYN.**
fraternella (Dietz 1900:113), *Pseudopigritia,* **N. SYN.**
argyreella (Dietz 1900:113), *Pseudopigritia,* **N. SYN.**
argyreela missp., Adamski & Brown (1989:25)
occidentella (Dietz 1900:115), *Dryope,* **N. SYN.**
erratella (Dietz 1910:4), *Dryope,* **N. SYN.**
murtfeldtella (Chambers 1874a:50), *Dryope*
luteopulvella (Chambers 1875b:73), *Dryope,* **N. SYN.**
spoliatella Dietz 1900:110, *Pigritia,* **N. SYN.**
pallidotinctella (Dietz 1900:111), *Epigritia,* **N. SYN.**
tenebrella (Dietz 1900:116), *Dryope,* **N. SYN.**
minnicella (Dietz 1900:116), *Dryope,* **N. SYN.**
minnieella Dietz 1900:120 missp.
grisella (Dietz 1900:116), *Dryope,* **N. SYN.**
fuscosuffusella (Dietz 1900:117), *Dryope,* **N. SYN.**
canariella (Dietz 1900:118), *Dryope,* **N. SYN.**
discopunctella (Dietz 1900:118), *Dryope,* **N. SYN.**
fenyesella (Dietz 1900:119), *Dryope,* **N. SYN.**
ochrocomella Clemens 1863:126, *Pigritia*
ochroeomella Dietz 1900:117, missp.
heidemannella (Dietz 1900:111), *Epigritia*

MASTEMA Adamski, *in* Adamski and Brown 1989:22

occidentalis Adamski, *in* Adamski and Brown 1989:22, *Mastema*

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A NEW SPECIES OF *GIGANTODAX* ENDERLEIN (DIPTERA: SIMULIIDAE) FROM THE UNITED STATES

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Abstract.—The larva, pupa, and adults of ***Gigantodax adleri,*** new species, are described from small springs in eastern Arizona and western New Mexico. This species represents the first United States record for the genus and a northern range extension of more than 3000 km. The preimaginal stages are associated with those of two species, *Simulium patziciaense* Takaoka and Takahasi and *Simulium puigi* Vargas, Martínez Palacios, and Díaz Nájera, not previously recorded north of Guatemala and southern Mexico, respectively. *Gigantodax adleri* belongs to the *Gigantodax wrighti* group of Wygodzinsky and Coscarón, and its life stages are superficially similar to those of several congeneric species. Diagnoses that differentiate the female, male, and pupa from those of all other species and a detailed description of the preimaginal habitat are provided.

Key Words: North America, springs, aquatic insect, Nematocera

Gigantodax Enderlein, with 67 currently recognized species, is the third largest black fly genus and the second largest in the southern hemisphere. Typically, it is placed within the Prosimuliini, which along with the Simuliini comprise the Simuliinae (Wygodzinsky and Coscarón 1973, 1989, Crosskey 1988, Takaoka et al. 1988, Vargas and Ramírez-Pérez 1989). Currie (1988), however, redefined the tribal limits within the Simuliinae and restricted the Prosimuliini to include only the following genera: *Prosimulium* Roubaud, *Helodon* Enderlein, *Urosimulium* Contini, *Levitinia* Chubareva and Petrova, *Gymnopais* Stone, and *Twinnia* Stone and Jamnback. As a result, *Gigantodax* and the remaining genera within the Simuliinae were assigned to the Simuliini, a view that is also corroborated by DNA sequence data (J. K. Moulton, unpublished).

Larvae of *Gigantodax* are the only ones in the family with a seventeen-toothed hypostoma, a complete, well sclerotized ring around the anal proleg, and posteroventrally directed struts underlying the base of the dorsal arms of the anal sclerite (Wygodzinsky and Coscarón 1989). The pupae are best known for their spectacular diversity in gill structure, which alone will separate many species. Some species, however, possess more typical gills and are scarcely separable from those of other genera. The adults are easily recognized by the straight, rather than sinuous, CuA_2 vein and the distinctive terminalia. The terminalia, however, are indistinguishable from those of species in the genus *Cnesia* Enderlein, which is its sister group (Wygodzinsky and Coscarón 1973, 1989).

The greatest diversity in this genus occurs in the Andes, but representatives of the *G. wrighti* species-group (Wygodzinsky and Coscarón 1989) are known as far north as the Sierra Madre de Occidental of central Mexico (Dalmat 1955, Vargas and Díaz Nájera 1957, Wygodzinsky and Coscarón

1989). Larval habitats range from small springs and rivulets to medium-sized rivers, and some species are found only in acidic or alkaline watercourses (Dalmat 1955, Wygodzinsky and Coscarón 1989). Females are presumably ornithophilic based upon the large basal tooth of the tarsal claw (Shewell 1955).

Wygodzinsky and Coscarón (1989) recognized eight species groups within *Gigantodax,* the *G. brophyi, G. cilicinus, G. cormonsi, G. cortesi, G. igniculus, G. minor, G. multifilis,* and *G. wrighti* groups, which contained 17, 11, 10, 4, 2, 4, 1, and 15 species, respectively, at that time. Since their treatise, three additional species have been described (Takaoka et al. 1988, Vargas and Ramírez-Pérez 1989). *Gigantodax biergi* and *G. willei,* described from Costa Rica by Vargas and Ramírez -Pérez (1989), belong to the *G. wrighti* group, and *Gigantodax lazoi,* described from Ecuador by Takaoka et al. (1988), is assignable to the *G. cormonsi* group.

In this paper, all life stages, after the egg, are described for a new species of black fly in the *G. wrighti* species group that represents the northernmost record for the genus and a new generic record for the United States. Also provided are diagnoses that differentiate the pupa and adults from those of all other species in the genus and a detailed account of the preimaginal habitat. The description below provides a name for this species that will enable its inclusion in a book on the black flies of North America being prepared by P. H. Adler, D. C. Currie, and D. M. Wood.

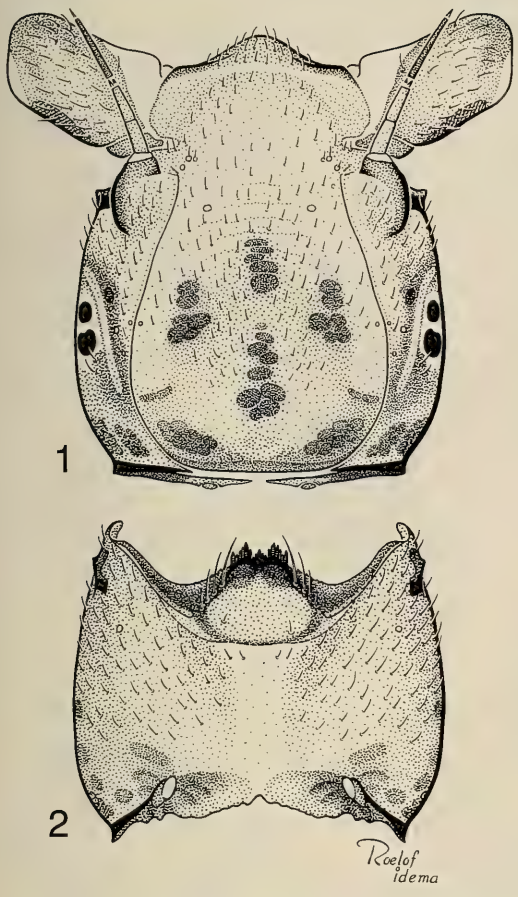
Materials and Methods

Life-stage descriptions largely follow that of Adler and Currie (1986). Taxonomic terms predominantly follow that of Peterson (1981). Representative larvae were preserved in absolute ethanol or Carnoy's fixative, while others were transported live to the laboratory and reared in water taken from the type locality and maintained at 10°C. All but one of the pupae and one of the two males were obtained from these rearings. The majority of adults were collected over the course of three days using an emergence trap placed directly above an exposed portion of the spring. The adults were placed into 95% ethanol immediately upon their discovery in the net. Paratype larvae, deposited in collections other than the author's, that were initially fixed in Carnoy's solution were transferred to 80% ethanol for permanent storage. Pupae were preserved in 60% ethanol to prevent collapsing of the gills, and then transferred to 80% ethanol for permanent storage. The holotype and all pinned adults were dehydrated with absolute ethanol and dried using hexamethyldisilazane, HMDS (Polysciences, Inc.). The holotype and some paratypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). Additional paratypes are deposited in the Canadian National Collection, Ottawa (CNC), The Natural History Museum, London (NHM), the American Museum of Natural History, New York (AMNH), and the author's personal collection (JKM). The figures of the larval head capsule, pupa, and male and female terminalia were drawn by Ralph Idema for the upcoming book on the black flies of North America and were made available to me by D. M. Wood. The remaining drawings were rendered by the author with the aid of an MTI CCD72 imaging system connected to an Olympus SZH10 stereo microscope. Length and width measurements were made using either this imaging system or by an ocular micrometer in an Olympus SZH zoom stereo microscope. Terminalia, mouthparts, and legs were cleared in 85% lactic acid to facilitate visibility and interpretation.

Description

Gigantodax adleri Moulton, new species
(Figs. 1–17)

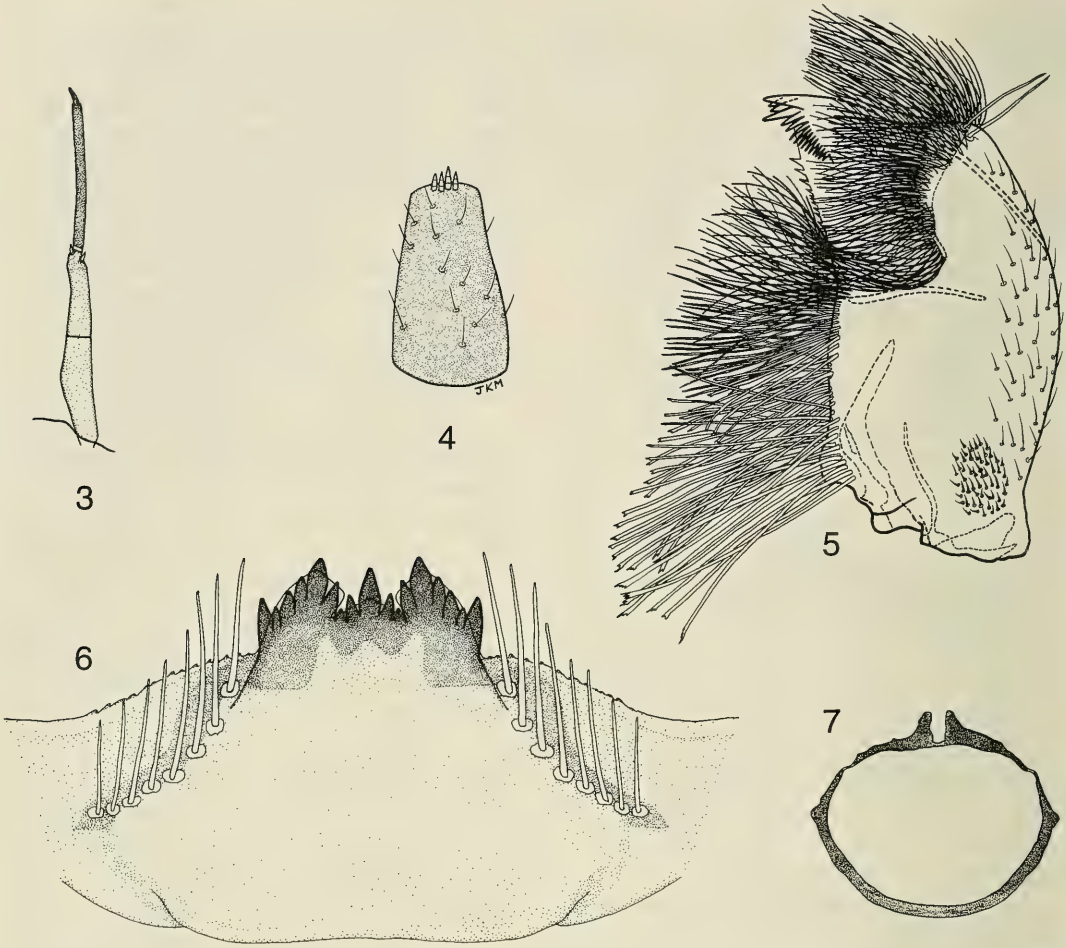
Larva (mature).—Length 6.9–7.2 mm (x = 7.0, n = 5). General color of larva pink-



Figs. 1–2. *Gigantodax adleri.* 1, Larval head capsule (dorsal view). 2, Larval head capsule (ventral view).

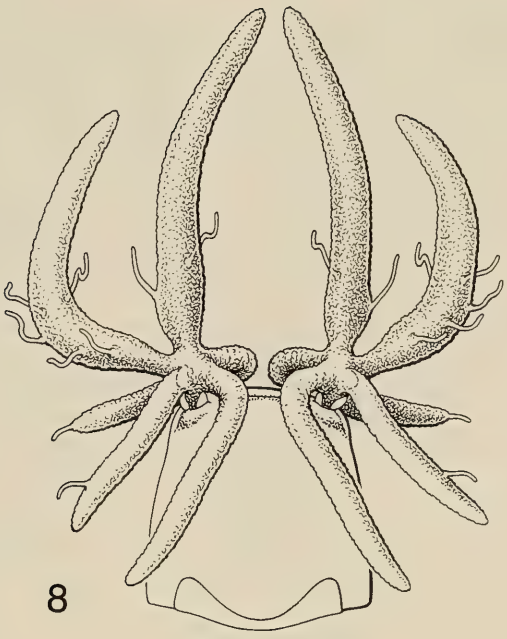
ish beige to brown; intersegmental bands poorly defined. Head capsule (Figs. 1, 2) extremely variable in color, ranging from pale yellowish brown with distinct, dark-brown headspots (pinkish beige larvae) to brown with headspots only slightly darker brown than background and rather indistinct (brown larvae). Headspots subequal in intensity and clearly comprised of multiple smaller spots; anterior posterolateral spot very small and concave; line over eyespots thin, brown, and with small oval spot positioned anterior of midlength. Antenna (Fig. 3) shorter than stem of labral fan, somewhat pigmented, with apical article darker than basal two; proportions of articles (distal to proximal) 1.4:1.0:2.3; terminal sensillum 3.4 times longer than basal width. Labral fan with 24–31 primary rays (x = 28, n = 4). Maxillary palpus (Fig. 4) about 1.9 times longer than basal width. Mandible (Fig. 5) with 10–11 inner teeth and 9–10 marginal serrations. Hypostomal bridge slightly darker than remainder of undersurface of head capsule, with faintly perceptible median longitudinal, light-colored stripe. Hypostoma (Fig. 6) with 17 teeth, one median tooth and 8 others per side; median tooth shorter than tallest lateral tooth; first tooth from median arising outwardly from near the base of median tooth; second tooth from median deeply set and barely surpassing dorsal wall; third tooth from median about as tall as median tooth; fourth tooth from median tallest tooth, its apex sloped outwardly; fifth and sixth teeth from median subequal in size although arising along downward slope; seventh tooth from median smallest of outer group of 5 teeth; eighth tooth from median prominent, its apex directed slightly inwardly. Lateral margin of hypostoma with 5–6 hypostomal setae and 7–8 lateral serrations per side. Postgenal cleft nearly imperceptible, at most a small notch. Cervical sclerites partially enclosed anteriorly by arms of postocciput. Thoracic proleg with lateral plate subquadrate, moderately sclerotized. Perianal scales not developed. Ventral papillae small, but distinct. Anal sclerite X-shaped, with heavily sclerotized, posteroventrally directed struts arising from base of anterior arms; posterior arms continuous as a well-sclerotized, thin, brown ring (Fig. 7) surrounding posterior proleg. Posterior proleg with approximately 135 rows, each with 20–27 hooks. Anal papillae of three simple lobes.

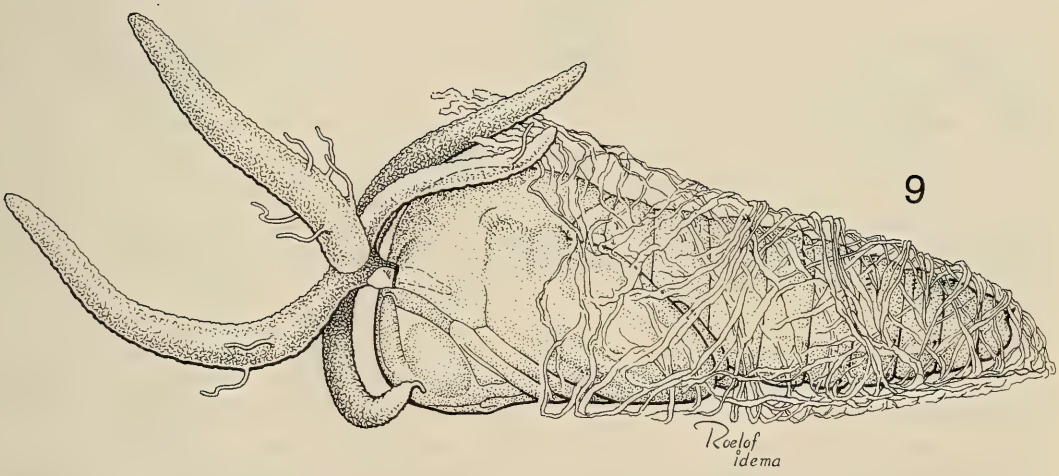
Pupa (Figs. 8–9).—Length of pupal body = 3.2–3.5 mm (x = 3.3, n = 5). Antenna sheath of female extended slightly beyond posterior margin of head; antennal sheath of male extended about 2/3 distance to posterior margin of head. Frontoclypeus of both sexes of normal shape, except for square protuberance medially, and with numerous



Figs. 3–7. *Gigantodax adleri.* 3, Larval antenna. 4, Larval maxillary palpus. 5, Left larval mandible (ventral view). 6, Larval hypostoma. 7, Larval anal salerite (terminal view).

regularly spaced, lightly verrucose platelets. Frontal and clypeal trichomes in the form of strong setae. Gill about 2/5–1/2 length of pupa, comprised of five, flimsy, pale gray, corrugated, tubular filaments arising individually from a short, common base; two dorsal branches directed posteriorly, two median branches directed anterodorsally, and a ventral branch directed posteriorly; dorsal branches simple or with one terminal or subterminal filament; median branches slightly thicker than others, the dorsalmost one with 4–5 and the other with 1–2 short, somewhat coiled filaments positioned just basal to midlength; ventral branch usually with one short apical filament. Thorax with numerous, rather regularly spaced, slightly verrucose platelets. Dorsocentral and dorsolateral trichomes setalike. Abdomen with platelets dorsally. Abdominal chaetotaxy as follows: tergite I with 4 setae per side; tergite II with 6–7 setae per side; tergites III and IV each with 4 retrorse hooks and 3 setae per side, one setae anterior to fourth hook from midline and 2 setae laterally; tergite V with 3 setae per side; tergites VI and VII with anterior row of spine combs and 1 seta per side; tergite VIII with anterior row of spine combs and 2–3 setae per side; tergite IX with pair of strong terminal

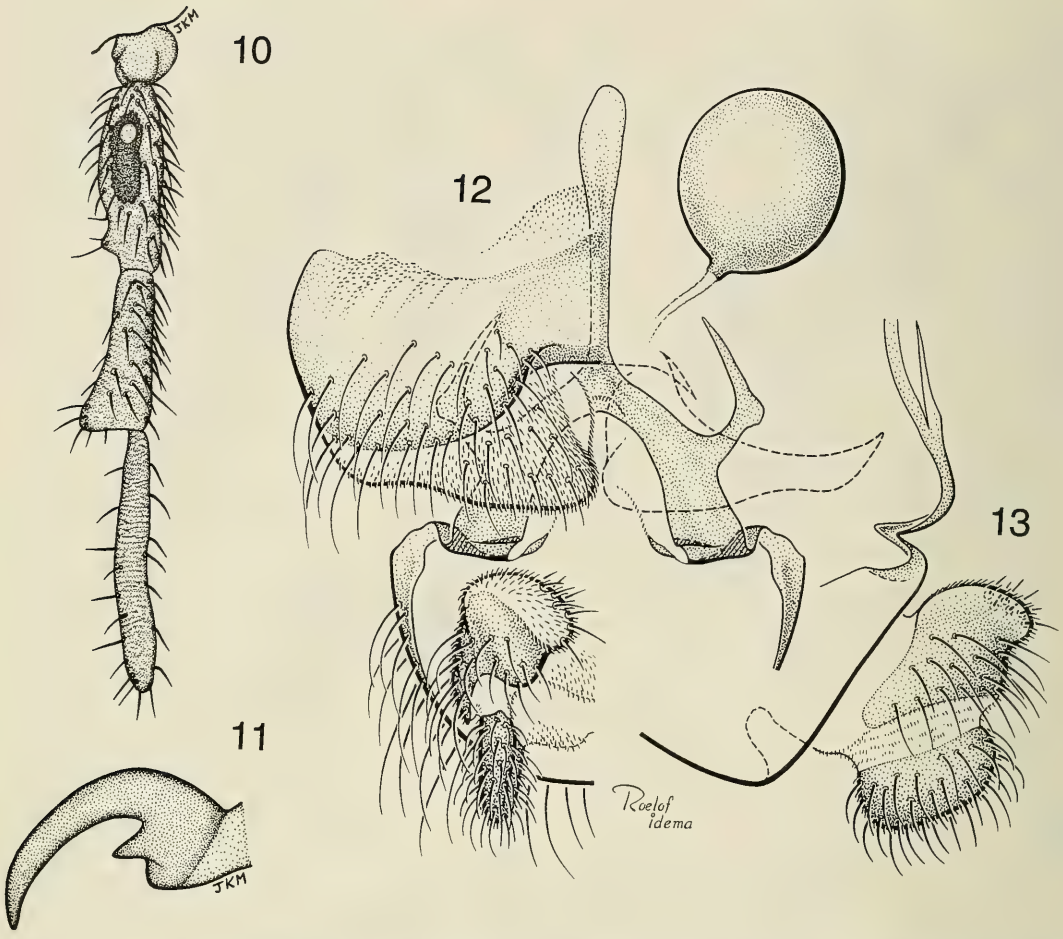




Figs. 8–9. *Gigantodax adleri.* 8, Pupal thorax and gills (dorsal view). 9, Pupa and cocoon (lateral view).

hooks and 2 setae per side. Sternite IV with 2 setae per side, situated medially; sternite V with 3 evenly spaced hook-like setae per side; sternite VI divided medially, each half with 2 short, grapnel-like hooks; sternite VII divided medially, each half with 1 grapnel-like hook; each half of sternites VI and VII bears a pleural sclerite with1 grapnel-like hook; sternite VIII glabrous; sternite IX with 3 long setae per side. Cocoon pale brown, covering abdomen and posterior portion of thorax, and often encrusted with small organic and inorganic particles.

Female.—General body color bright orange with golden pile. Length: thorax 1.2–1.4 (x = 1.3, n = 4) mm; wing 3.4–4.4 (x = 4.0, n = 4) mm. Frons gray, at vertex about 3 times broader than at narrowest



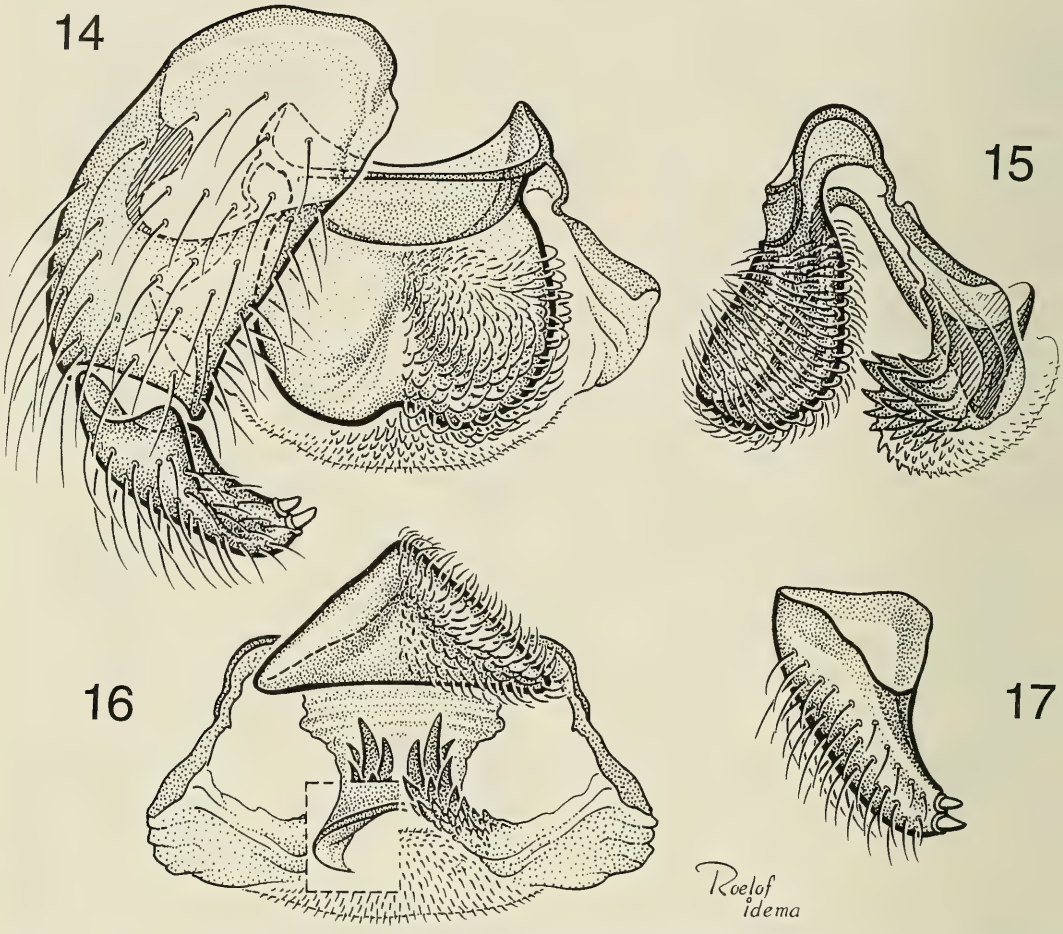
Figs. 10–13. *Gigantodax adleri.* 10, Female left maxillary palpus (dorsal view). 11, Female tarsal claw (lateral view). 12, Female terminalia (ventral view with left anal lobe and cercus removed). 13, Female right anal lobe and cercus (lateral view).

point, with sparse golden pile. Frontal angle 77°. Fronto-ocular triangle about as high as wide. Clypeus brown, about as long as wide, with golden pile. Occiput gray, with golden pile reaching posterior margin of eye; postocular setae golden. Antenna with brown pile; scape and pedicel orange; flagellum orange, with apical two flagellomeres slightly darker. Proboscis brown. Mandible with 20 teeth along inner margin. Lacinia with 18 retrorse teeth. Palpus brown, with stout brown setae; ratio of palpomeres (Fig. 10) 1.2:1.0:1.6; sensory vesicle of palpomere III elongate, about 0.6 times length of segment, with external opening rounded and at end of short neck. Median proximal space of cibarium broadly U-shaped, lacking setae or armature. Postpronotum light brown, with golden pile. Proepisternum light brown, with tuft of long golden setae. Scutum bright orange, with purple-brown border from lateral of midline to superalar region; anterior portion of this border extended posteriorly as a pair of thin, longitudinal stripes extended to scutellum; between this pair of stripes is a median stripe of similar color that also reaches posterior declivity; scutum clothed in decumbent golden pile, with posteriormost portion also with long golden brown recumbent setae.

Anepisternum and katepisternum yellowish orange; membranous regions pale brown. Region anterior of mesothoracic spiracle purple brown. Mesepimeral tuft golden brown. Mesbasisternum yellowish orange, rimmed in purple brown. Scutellum beige, with long, golden-brown setae, these being recumbent anteriorly and decumbent posteriorly. Metanotum dull orange brown, anterior 1/3 shiny brass brown. Wing translucent Veins pale brown. Setae of stem vein and all other veins dark brown. Costa (C) with simple setae proximal to and simple setae and spinelike setae distal to about midpoint of subcosta (Sc). Sc haired ventrally. R_1 with one or two rows of setae, spinules present but not numerous, beginning apical to level of insertion of Sc with C. Rs simple, without any trace of forking. False vein forked apically. M_1 and M_2 nearly straight, reaching wing margin. CuA_1 and CuA_2 straight, reaching wing margin. A_1 straight, nearly reaching wing margin. A_2 strongly curved, not nearly reaching wing margin. Halter whitish, slightly tinged with brown, especially on capitulum. Legs yellow brown, with golden-brown, simple setae. Procoxa brown. Probasitarsus 13 times as long as wide. Mesocoxa and metacoxa yellowish orange. Metafemur with apex brown. Metatibia with base and apex brown. Metabasitarsus 7.5 times as long as wide. Calcipala rounded, extended to center of second tarsomere. Pedisulcus a series of shallow wrinkles along slightly concave surface of second tarsomere. Basal tooth of claw (Fig. 11) triangular, about 1/4 as long as claw. Abdominal tergites piceous, orange brown, with golden pile center of tergites pale brown, with posterior margin clothed with golden pile interspersed with sparse, brown pile. Membranous areas gray. Sternites orange brown with golden pile. Abdominal fringe beige, with long golden setae. Terminalia (Figs. 12–13) weakly sclerotized. Genital fork with stem expanded apically, arms expanded distally, and with long angled, dorsomedially projected apodemes. Ovipositor flaps broadly rounded and with numerous setae. Spermatheca spherical, brown, moderately sclerotized, lacking noticeable sculpturing, and with distinct neck at junction with spermathecal duct. Anal lobe subquadrate, with somewhat prominent rounded lobe ventrally. Cercus flat, rounded posteriorly, the sclerotized apical portion about twice as tall as wide.

Male.—Thorax length 1.1–1.2 ($x = 1.2$, $n = 2$) mm. Wing length 3.1–3.2 ($x = 3.1$, $n = 2$) mm. Identical to that of female except as noted. Clypeus reduced to a narrow strip, with long brown pile. Sensory vesicle subglobular, with distinct neck, 0.4 times length of palpomere. Scutum with dark brown recumbent setae posteriorly. Procoxa yellowish orange. Wing much as in female, except spines on C beginning near junction of R_1 + Rs and spines of R_1 beginning at junction of C and Sc. Scutellum shiny brass brown, with long dark-brown setae. Protarsus brown. Probasitarsus 8.5 times as long as wide. Meta basitarsus 5.3 times as long as wide. Abdominal tergites and sternites brown with anterior and posterior margins paler brown; membranous regions gray. Terminalia (Figs. 14–17) weakly sclerotized. Gonocoxite about three times longer than greatest width. Gonostylus about two-thirds as long as basimere, with two apical spines. Ventral plate about as wide as long, with median carina, and characteristic horizontal bridge connecting anterior arms. Median sclerite forked, the tines about 1/3 length of structure. Paramere weakly sclerotized distally, apex membraneous and armed with approximately 12 large spines and several additional spines progressively smaller proximally.

Types.—Holotype: ♀ (pinned), USA: ARIZONA: Apache County, Government Spring, 50 m S of Forest Service Road 1120 (33°59′34″N, 109°27′54″W), elev. 8500 ft. (2591 m), 21 May 1994, J. K. Moulton (USNM). Paratypes: same data as holotype, except May 21–24 1994—8 larvae [4 Carnoy's (CNC), 4 absolute ethanol (JKM)], 1 pharate pupa (JKM), 7 pupae (2 each in



Figs. 14–17. *Gigantodax adleri.* 14, Male terminalia (ventral view with left gonocoxite and gonostylus removed). 15, Male ventral plate, median sclerite, and parameres (lateral view). 16, Male ventral plate, median sclerite, and parameres (terminal view). 17, Male right dististylus (dorsal view).

USNM and JKM, 1 each in CNC, NHM, and AMNH), and 4 pinned ♀s (1 each in CNC and NHM, 2 in JKM); same data, except 10 October 1994—10 larvae [5 Carnoy's (NHM), 5 absolute ethanol (JKM)]. Unnamed rivulet-like spring ca. 400 m S of Government Spring, 18 May 1994, J. K. Moulton—6 larvae (Carnoy's) and 1 pharate ♂ (in ethanol) (JKM). Small spring (seep) ca. 100 m N of Government Spring, 18 May 1994, J. K. Moulton—4 larvae (JKM). Graham County, Pinaleno Mountains, Twilight Spring @ Rt. 366, mile-marker 127 (32°40′47″N, 109°51′22″W), elev. ca. 7000 ft. (2134 m), 15 March 1995, J. K. Moulton—1 larva (JKM). NEW MEXICO: Catron County, Fanny Spring @ Rt. 159 (Bursum Rd.) 4.2 km E of Mogollon (33°22′55″N, 108°45′59″W), elev. ca. 9000 ft (2744 m), 20 May 1995, J. K. Moulton—7 larvae, 1 pupa (NHM); same data, except 5 June 1995—4 larvae (NHM).

Etymology.—This remarkable species is named in honor of Peter H. Adler, a dear friend and mentor to whom I will be forever grateful for introducing me to the intriguing world of simuliids.

Diagnosis.—Female: The following suite of characters distinguishes this species from all others in the genus: (1) scutum bright

orange, bordered with purple brown, and clothed with golden-yellow pile; (2) setae of stem vein, legs, and scutellum dark golden brown; (3) mandible with 20 teeth along inner margin; (4) lacinia of maxilla with 18 teeth; (5) calcipala extended to 1/2 length of second tarsomere; and (6) basal tooth of claw small, triangular, about 1/5–1/4 as long as claw. Male: The bright orange, purple-brown bordered scutum clothed with golden pile, R_1 with spines, and dark brown stem vein and scutellar setae separate this species from all other species in the genus. Pupa: The five, flimsy, pale gray, tubelike filaments of the respiratory organ distinguishes this species from all others except *G. nasutus* Wygodzinsky and Coscarón. The gill of *G. adleri* differs from that of *G. nasutus* in the following regards: (1) filaments less stout, especially basally, not arising from a somewhat swollen gill base, (2) filaments directed more anterolaterally than anteriorly, and (3) second filament from dorsal and ventralmost filaments not strongly curved ventrally and dorsally, respectively, and pressed against the anterolateral portion of body. The protuberance of the frontoclypeus of *G. adleri* further distinguishes it from *G. nasutus* and possibly all other species. Larva: Larvae in this genus are not sufficiently characterized to make accurate species-level diagnoses without the presence of a respiratory histoblast. A preliminary analysis of larvae of several species indicates that those of many species are separable using nothing more than body coloration and pigment distribution if fixed in Carnoy's.

Remarks.—The preimaginal stages occur in springs approximately 0.1–1.0 m wide, a few cm deep, and less than 75 m in length. The temperature at the source of these springs is about 8–10°C, although during the day the temperature downstream may reach 15°C. The type locality, Government Spring, is the largest of three closely situated springs issuing from the western ridge of Lee Valley, just south of the town of Greer in the shadow of Baldy Peak (11,403 ft., 3477 m). Government Spring percolates at a modest rate through stones and herbaceous vegetation. The streambed is approximately 4 m in width, but the spring diverges such that any particular flow is only a few cm wide. The spring was once the water source for a Civilian Conservation Corps (CCC) trout hatchery (Peter Taylor—United States Forest Service, Apache-Sitgreaves Division, personal communication). Remnants of concrete pipes through which the spring is still partially diverted and six rectangular, trough-like, earthen holding tanks are clearly evident. Two other simuliids, *Simulium hechti* Vargas and Díaz Nájera and *S. patziciaense* Takaoka and Takahasi, belonging to the *Simulium hunteri* species-group were also found in the type locality. *Simulium patziciaense* was previously known only from Guatemala (Takaoka and Takahasi 1982). The dominant organism by far in the type locality was an *unidentified* species of amphipod.

The remaining two apparently unnamed springs near the type locality supported much smaller populations of both simuliids and amphipods. One is located approximately 400 m south of the type locality and is rivulet-like, with water flowing over large flat rocks and between large rocks and boulders. Located approximately 100 m north of Government Spring, the other spring is slow-flowing and has a mud bottom with few rocks and sparse vegetation. Associated with this new species in the rivulet was *Prosimulium travisi* Stone. No other simuliids were present in the mud-bottomed spring. The only other significant population of this species was found near the origin of Fanny Spring near the historic mining town of Mogollon, New Mexico. This spring is similar to the type locality in that it is well shaded and has watercress as the dominant herbaceous plant. Associated with this species in Fanny Spring were *S. patziciaense, S. piperi* Dyar and Shannon, and *S. puigi* Vargas, Martínez Palacios, and Díaz Nájera. *Simulium puigi* was previously known only from Chiapas, Oaxaca, Vera-

cruz, and Guatemala (Vargas et al. 1946, Takaoka and Takahasi 1982).

Larvae seem to prefer flat surfaces of rocks and the undersides of watercress leaves as substrates. Pupae were difficult to find at the type locality. Undoubtedly, the final instar larva moves into cracks and cervices of rocks or into filamentous algae to spin its flimsy cocoon, which becomes further obscured by the accumulation of debris. Of the two field-collected pupae, the one found at the type locality was in a clump of algae, and the one from Fanny Spring was on the underside of a watercress leaf. All laboratory-reared pupae were removed from crevices formed by parts of the stone bubbler assembly. Based upon the presence of numerous larvae of different size classes in both May and October, this species is presumably multivoltine. It is not known whether eggs or larvae overwinter.

The habitats described are potentially refugia, since they are inhabited by two species, *S. patziciaense* and *S. puigi,* previously known only from southern Mexico to Guatemala, and by *G. adleri,* whose closest relatives occur from southern Mexico to northern South America. On the other hand, these disparate distributions may be nothing more than an artifact resulting from a lack of faunistic research between these regions. Regardless, it is likely that additional species of *Gigantodax* occur in similar montaine habitats between southern Arizona and central Mexico.

Acknowledgments

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LIFE HISTORY AND DESCRIPTIONS OF ADULTS AND IMMATURE STAGES OF *ACIURINA SEMILUCIDA* (BATES) (DIPTERA: TEPHRITIDAE) ON *CHRYSOTHAMNUS VISCIDIFLORUS* (HOOKER) NUTTALL IN SOUTHERN CALIFORNIA

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Abstract.—*Aciurina semilucida* (Bates) is a rare, highly localized, tephritid fly forming pubescent, axillary bud galls on branches of *Chrysothamnus viscidiflorus* (Hooker) Nuttall in southern California. Documentation is provided that the wing patterns of the adults are very strongly sexually dimorphic in southern California, but much less dimorphic in some other parts of its range, e.g. in Idaho, where it previously has been reported only from *C. nauseosus* (Pallen) Britton. The egg, first-through third-instar larvae, and puparium are described, illustrated, and compared with other southern California *Aciurina* spp. The egg has a long pedicel, with a knoblike anterior apex. The second and third instars have abdominal terga III–V expanded into a dorsal ambulatory lobe. This ambulatory lobe and the large open gall cavity within which the larva feeds are characteristics shared only with *A. michaeli* Goeden among southern California *Aciurina* spp. studied to date.

Key Words: Insecta, *Aciurina, Chrysothamnus,* biology, galls, regional sexual dimorphism, adult taxonomy, immature taxonomy, parasitoids

Six *Aciurina* spp. (Diptera: Tephritidae) forming galls on *Chrysothamnus* or *Baccharis* spp. (Asteraceae) in southern California have been studied by us to date. This paper follows those on *A. thoracica* Curran (Headrick and Goeden 1993), *A. ferruginea* (Doane), *A. michaeli* Goeden (Goeden and Teerink 1996a), and *A. idahoensis* Steyskal (Goeden and Teerink 1996b), in a series projected to end with *A. trixa* Curran [as interpreted and reinstated by Dodson and George (1986)], which is the most common species of *Aciurina* in California (D. H. Headrick, RDG, and JAT, unpublished data). Steyskal (1984) erroneously synonymized *A. semilucida* (Bates) with *A. bigeloviae* (Cockerell) and *A. trixa* (Dodson and George 1986) to make *A. bigeloviae* ". . . the most widely distributed and most variable of all the *Chrysothamnus*-feeding *Aciurina* species . . ." (Foote et al. 1993). Instead, *A. semilucida* (Bates) is the rare, localized, and distinct species in California that we describe herein.

MATERIALS AND METHODS

Our field studies were conducted on *Chrysothamnus viscidiflorus* (Hooker) Nuttall (Asteraceae) at three locations in Deep Spring Valley, the southernmost extension of the Great Basin biome (Munz 1974, Hall 1991), located northeast of the Westgard Pass in the White-Inyo Mountain Range, Inyo Co., California. Galls containing larvae and puparia of *A. semilucida* were sampled from plants in Payson Canyon at 1770 m at the southwest end of the Valley, north of Deep Spring Lake at 1720 m towards the center of the Valley, and above Antelope Spring at 1695 m on the north side of the

Valley during March and April, 1993 and 1994. Excised galls were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Two first-instar, five second-instar, and 18 third-instar larvae and two puparia dissected from galls were preserved in 70% EtOH for scanning electron microscopy (SEM). All other fully grown larvae and puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM later were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24 h, dehydrated through an increasing series of acidulated EtOH, critically point dried, mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screened-top cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cagings were used for longevity studies and oviposition tests in the insectary of the Department of Entomology, University of California, Riverside, at 25 ± 1°C, and 14/10 (L/D) photoperiod. Virgin male and female flies obtained from emergence vials as well as field-swept adults were paired in clear-plastic petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey (Headrick and Goeden 1991) for direct observations, videorecording, and still-photography of their courtship and copulation behavior to be reported elsewhere (Headrick and Goeden, unpublished data).

Plant names used in this paper follow Munz (1974); tephritid nomenclature and terminology follow Foote et al. (1993) as modified by Dodson and George (1986). Morphological terminology and telegraphic format used to describe the immature stages follow Headrick and Goeden (1993) and Goeden and Teerink (1996a, b) and our earlier works cited therein. Means ± SE are used throughout this paper. Voucher specimens of reared adults of *A. semilucida* reside in the research collection of RDG; preserved specimens of eggs, larvae, and puparia are stored in the research collection of JAT.

Results and Discussion

Taxonomy

Adult.—*Aciurina semilucida* was described (as a *Tephrella*) by Bates (1935) from five males and seven females reared from galls on *Chrysothamnus* (as *Bigelovia*) sp. from Riparia, Washington. The host plant of *A. semilucida* was further identified as *C. nauseosus* (Pallen) Britton in Idaho by Novak et al. (1967). Curran (1932) erected the genus *Aciurina* and designated the type species as *A. trixa.* Steyskal (1984) synoptically revised the genus, and Foote et al. (1993) adopted his revision, which synonymized both *A. trixa* and *A. semilucida* with *A. bigeloviae.* Unfortunately, Steyskal (1984) and Foote et al. (1993) were unaware that several North American species of *Aciurina* have sexually dimorphic wing patterns, e.g. *A. ferruginea, A. michaeli,* and *A. idahoensis* (Goeden and Teerink 1996a, b, unpublished data). Furthermore, *A. idahoensis* shows regional variation in this dimorphism, i.e. being strongly dimorphic in California, but less so in Idaho (Goeden and Teerink 1996b).

Before redescribing the adults of what we believe are *A. semilucida* in California, we provide our reasons for identifying them as such. First, *A. semilucida* was reported by Wangberg (1981) from galls on *C. nauseosus* similar to those found by us on *C. viscidiflorus* in California; however, in Idaho, *A. semilucida,* like *A. idahoensis* (Goeden and Teerink 1996b), is much less sex-

ually dimorphic. Steyskal (1983) believed that *A. semilucida* "... *was no more than A. bigeloviae* with a strongly reduced wing pattern." Accordingly, he synonymized *A. semilucida* with *A. bigeloviae,* along with *A. trixa,* the resulting species representing what he termed "... the most widely distributed and most variable of all the *Chrysothamnus*-feeding species, that is, the typical group of *Aciurina.*" Dodson and George (1986) concluded, however, that *A. trixa* is a separate and distinct species forming smooth galls on *C. nauseosus*; whereas, *A. bigeloviae* forms "cottony" galls on this same host plant. Neither *A. bigeloviae* nor *A. trixa* apparently exhibited sexually dimorphic wing patterns, although considerable wing pattern variation was reported after extensive field and laboratory studies by Dodson and George (1986) in Arizona, Colorado, New Mexico, and Utah. However, only *A. trixa* apparently occurs on *C. nauseosus* in California, as no cottony galls of *A. bigeloviae* have ever been found on this widely distributed host plant extensively studied by us throughout its range in southern California (D. H. Headrick, RDG, and JAT, unpublished data). Only *A. trixa* was reared from smooth galls on *C. nauseosus* at our study site, where *A. semilucida* was found only on *C. viscidiflorus.*

Figure 1A and 1B respectively show the right wings typical of voucher specimens of male and female *A. semilucida* reared from galls on *C. nauseosus* collected from near Lewiston, Nez Perce Co., Idaho, where Wangberg (1981) studied this species. Figure 1C and 1D respectively depict a male and female with the more darkly patterned condition and the variation found among these same voucher specimens examined from Idaho. Compare the aforementioned wing patterns with those of a male (Fig. 1E) and female (Fig. 1F) that we call *A. semilucida* reared from similar galls on *C. viscidiflorus* in southern California. The wing patterns of the males from California and Idaho compare favorably; whereas, the females from southern California have a much different wing pattern (i.e. the California population has strongly sexually dimorphic wing patterns). The wing pattern of these southern California females (Fig. 1F) is similar to that of *A. lutea* (Coquillett) as pictured and described in Steyskal (1984) and Foote et al. (1993). *Aciurina lutea* is a rare but widely distributed species that has been reported only from *C. viscidiflorus* (Wangberg 1981, Steyskal 1984, Foote et al. 1993). However, in both female California *A. semilucida* and *A. lutea* neither hyaline mark in cell m crosses vein M (Fig. 1F), as does the apical mark in *A. bigeloviae* and *A. trixa* (Headrick, RDG, and JAT, unpublished data). Furthermore, A. L. Norrbom (1996, in litt.) reports that three males of *A. lutea* in the U.S. National Museum collection (from northern California, Nevada, and Utah) have the same wing pattern as the female holotype (i.e. like Foote et al. 1993, Fig. 115), and thus are quite different from California males of *A. semilucida.* Moreover, *A. semilucida* has a densely gray microtrichose scutum with white to yellow, stout setulae (see below); whereas, these three *A. lutea* males have a mostly bare, shiny scutum with slender, black setulae (Norrbom, in litt., 1996). Also, in *A. lutea,* the subapical hyaline spot in cell dm touches or approaches vein M, but is well isolated from vein CuA_1 (Norrbom, in litt., 1996); whereas, cell dm touches CuA_1 in *A. semilucida* (see below). Finally, Wangberg (1981) pictured and described the gall of *A. lutea* as a simple, but abrupt, woody swelling with thickened walls on older stems as well as current year's stem growth. Thus, its reported gall is definitely different from that which we describe below.

Knowing now that sexually dimorphic wing patterns occur in some species of *Aciurina* (Goeden and Teerink 1996a, b), and that this dimorphism may occur or nearly be absent within different parts of the range of a single species (Goeden and Teerink 1996b), we conservatively chose to identify the flies with which this paper is concerned

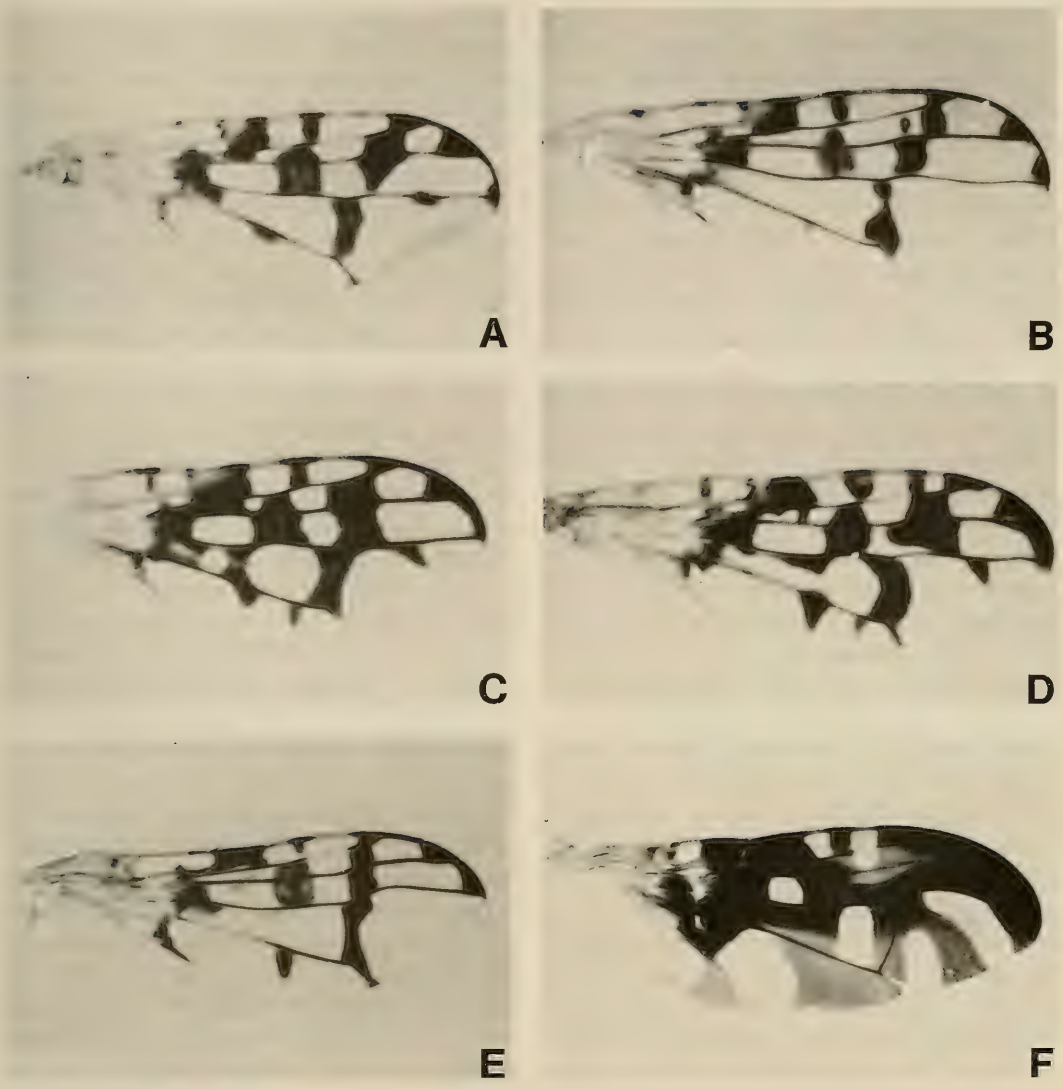

Fig. 1. Right wings of *Aciurina semilucida.* (A) Light form of male from Idaho; (B) light form of female from Idaho; (C) dark form of male from Idaho; (D) dark form of female from Idaho; (E) male from California; (F) female from California.

as *A. semilucida.* Accordingly, males (Fig. 1A, 1C) and females (Fig. 1B, 1D) of *A. semilucida* examined from Idaho and males from California (Fig. 1E) generally appear like the two most hyaline wing patterns (>50% hyaline) among the four patterns illustrated for *A. bigeloviae* by Steyskal (1984, Fig. 15–16). Put another way, these two illustrations in Steyskal (1984) respectively represent the light and dark wing patterns found among both males and females of *A. semilucida* from Idaho (Fig 1A–D), but only among males (Fig. 1E) from California. Similarly, the most hyaline wing pattern of the three patterns for *A. bigeloviae* illustrated by Foote et al. (1993, Fig. 124) is generally illustrative of the wing patterns of males and females of *A. semilucida* from Idaho and the males from California. This suggested relabeling parallels

that applicable to the wing pattern of male *A. idahoensis* from California, which closely resembles that illustrated for *A. notata* in Steyskal (1984) and Foote et al. (1993) [but see discussion in Goeden and Teerink (1996b) of inconsistencies between published reports on *A. idahoensis* and *A. notata*]. The males of *A. idahoensis* from California and males of *A. semilucida* both have reduced wing patterns and mostly hyaline wings, but are readily separated by the much more reduced pattern in the wings of the former males (Goeden and Teerink 1996b).

Females from California.—Apparently, females of *A. semilucida* in southern California have a wing pattern (Fig. 1F) that heretofore has neither been recognized nor described. Or they have been subsumed until now, like other species noted above, as one of the dark patterned wing forms of *A. bigeloviae* or, conceivably, *A. lutea,* as distinguished and illustrated by Steyskal (1984) and Foote et al. (1993). The following description of the California form of *A. semilucida* female is based on three females individually reared from galls collected at our Payson Canyon study site. Figure 1F is a photograph of the right wing excised from one of these three females.

Head: White with golden yellow antennae, frons, and ventral occiput. Three pairs of frontal bristles, basally yellow, light brown distally; two pairs of orbital bristles, the anterior pair light brown, posterior pair light yellow; inner vertical bristles and ocellar bristles well developed and light brown; other bristles wholly or basally white or light yellow.

Thorax: Dark brown, mesonotum covered with fine grey pollinosity and many, prominent, pale to golden yellow setulae posteriorad as far as and including all but shiny, posterior margin of dark brown or black scutellum. Mediotergite black, shiny medially, grey pollinose dorsally and laterally. All of the following paired bristles are present and yellow-brown: One postpronotal; scapular bristles indistinguishable from setulae or absent; one postsutural dorsocentral slightly posteriorad of pre-sutural supra-alar, at half the distance to the supra-alar bristle; two notopleurals; one each of post-alar, intra-alar, and acrostical; scutellum with one basal, prominent, scutellar bristle; katepisternal bristle well developed. Coxae, femora, tibiae, and tarsi yellow; fore femur, unlike male, unthickened, but also bearing loose "comb" of long, anteroventral setae. Wings (Fig. 1F) mostly dark brown, with marginal hyaline incisions and internal marks as follows: cell bc wholly yellow; cell c with basal and median dark or hyaline spots, if the latter, also with small, apical, marginal hyaline incision; cell r_1 with one or two hyaline spots along costa, if one, the spot extending halfway across cell r_1, if two, the proximal spot extending to vein R_{2+3}, the distal spot across cells r_1 and r_{2+3} to vein R_{4+5} (Fig. 1F) or across r_1, r_{2+3} and r_{4+5} to vein M; cell r_{4+5} with a distinct bulla; cell dm with prominent preapical hyaline spot touching both veins M and CuA_1, just CuA_1, or neither vein; cell m with median, hyaline, wedge-shaped mark reaching or nearly reaching anteriorly-bowed vein M and sub-basal, hyaline, wedge-shaped spot half as long; vein dm-cu bowed apicad; cell br with prominent preapical spot; cell cua_1 with one or two marginal hyaline incisions, apical incision absent or reaching CuA_1 and contiguous with preapical spot in cell dm, and prominent basal incision starting basad of and crossing vein A_1+CuA_2 and extending anteriorly to or nearly to CuA_1; alula and adjacent base of anal lobe hyaline.

Abdomen: Shiny, reddish-brown, except for tergite 6, which may be dark brown, oviscape shiny black; tergum sparsely covered with fine, light yellow setulae.

Males and Idaho females.—The wings of 12 males of *A. semilucida* examined from California and 40 males and 20 females examined from Idaho characteristically are >50% hyaline (Fig. 1A–E), and are described here collectively: Cell bc wholly hyaline; cell c wholly hyaline or yellow or

with a small central brown spot; brown or yellow-brown band covering veins bm–cu and r–m; apices of cells r_{2+3} and r_{4+5} narrowly brown; brown spot arising midway on vein CuA_1; usually brown crossband running from apex of cell r_1 across vein dm-cu, varying in width, sometimes interrupted in cell r_{2+3}, or more commonly, broken or attenuated at or before vein M. These spots connected or variously embellished in darker wing patterns (Fig. 1C, 1D).

Immature stages.—Egg: Fifteen ova of *A. semilucida* were white, opaque, smooth; with an elongate-ellipsoidal body, 0.52 ± 0.007 (range, 0.46–0.56) mm long, 0.21 ± 0.008 (range, 0.16–0.26) mm wide, smoothly rounded at tapered posterior end; with an elongate, anterior pedicel, 0.25 ± 0.008 (range, 0.20–0.30) mm long, 0.03 (range, 0.02–0.04) mm wide medially, and 0.05 (range, 0.04–0.06) mm wide at knoblike, anterior apex.

The eggs of *A. semilucida* are stalked like those of *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996a) and *A. idahoensis* (Goeden and Teerink 1996b), all four of which differ greatly in appearance from the short-pedicelled, partly reticulated egg of *A. thoracica* (Headrick and Goeden 1993). The respiratory function of the elongate pedicel of these eggs was first suggested for *A. michaeli* by Tauber and Tauber (1967) and was supported with morphological and biological data by Goeden and Teerink (1996a). The egg bodies and pedicels of *A. idahoensis* and *A. semilucida* are shorter on average than these parts of the eggs of both *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996a, b), with *A. semilucida* having the shortest pedicel of the three species.

Third instar: Superficially smooth, pyriform, tapering anteriorly, truncated posteriorly, abdominal segments III–V enlarged dorsally, minute acanthae ventrally (Fig. 2A); gnathocephalon conical, rugose pads mediad of anterior sensory lobes and laterad of mouth lumen (Fig. 2B-1); pair of enlongated dorsal petals dorsad of mouth lumen (Fig. 2B-2); paired dorsal sensory organs dorsomediad of anterior sensory lobes, each consisting of dome-shaped papilla (Fig. 2B-3, 2C-1); anterior sensory lobes bear terminal sensory organ (Fig. 2C-2), pit sensory organ (Fig. 2C-3), lateral sensory organ (Fig. 2C-4), and supralateral sensory organ (Fig. 2C-5); stomal sense organs ventrolaterad of anterior sensory lobes (Fig. 2D-1); lateral sensillum located laterad of anterior sensory lobe (Fig. 2B-4); ventrolateral sensillum ventrolaterad of stomal sense organ (Fig. 2D-2); mouth hooks bidentate, teeth conical (Fig. 2D-3); median oral lobe laterally flattened, tapering apically (Fig. 2D-4); prothorax smooth, minute acanthae ventrally (Fig. 2B-5); anterior thoracic spiracles dorsolaterad on posterior margin of prothorax with three oval papillae (Fig. 2E); metathoracic lateral spiracular complex consists of an open spiracle (Fig. 2F-1), and two verruciform sensilla (Fig. 2F-2); abdominal lateral spiracular complex consists of an open spiracle and a single verruciform sensillum; caudal segment bears the posterior spiracular plates (Fig. 2G); posterior spiracular plates with three oval rimae, ca. 0.042 mm in length (Fig. 2G-1), and four interspiracular processes, longest measuring 0.01 mm (Fig. 2G-2); compound sensilla ventrad of posterior spiracular plates consist of a stelex sensillum (Fig. 2H-1) and a verruciform sensillum (Fig. 2H-2); stelex sensilla surround margin of caudal segment in 2-dorsal, 4-ventral arrangement.

Aciurina semilucida closely resembles *A. michaeli* in general, third-instar habitus (Goeden and Teerink 1996a). Both species are enlarged dorsally and have a distinct hump, which differentiates them from other *Aciurina* species studied thus far, i.e. *A. thoracica* (Headrick and Goeden 1993), *A. ferruginea* (Goeden and Teerink 1996a), *A. idahoensis* (Goeden and Teerink 1996b) and *A. trixa,* (Goeden, unpublished data). *Aciurina semilucida* and *A. michaeli* are very similar in the types, sizes, and place-

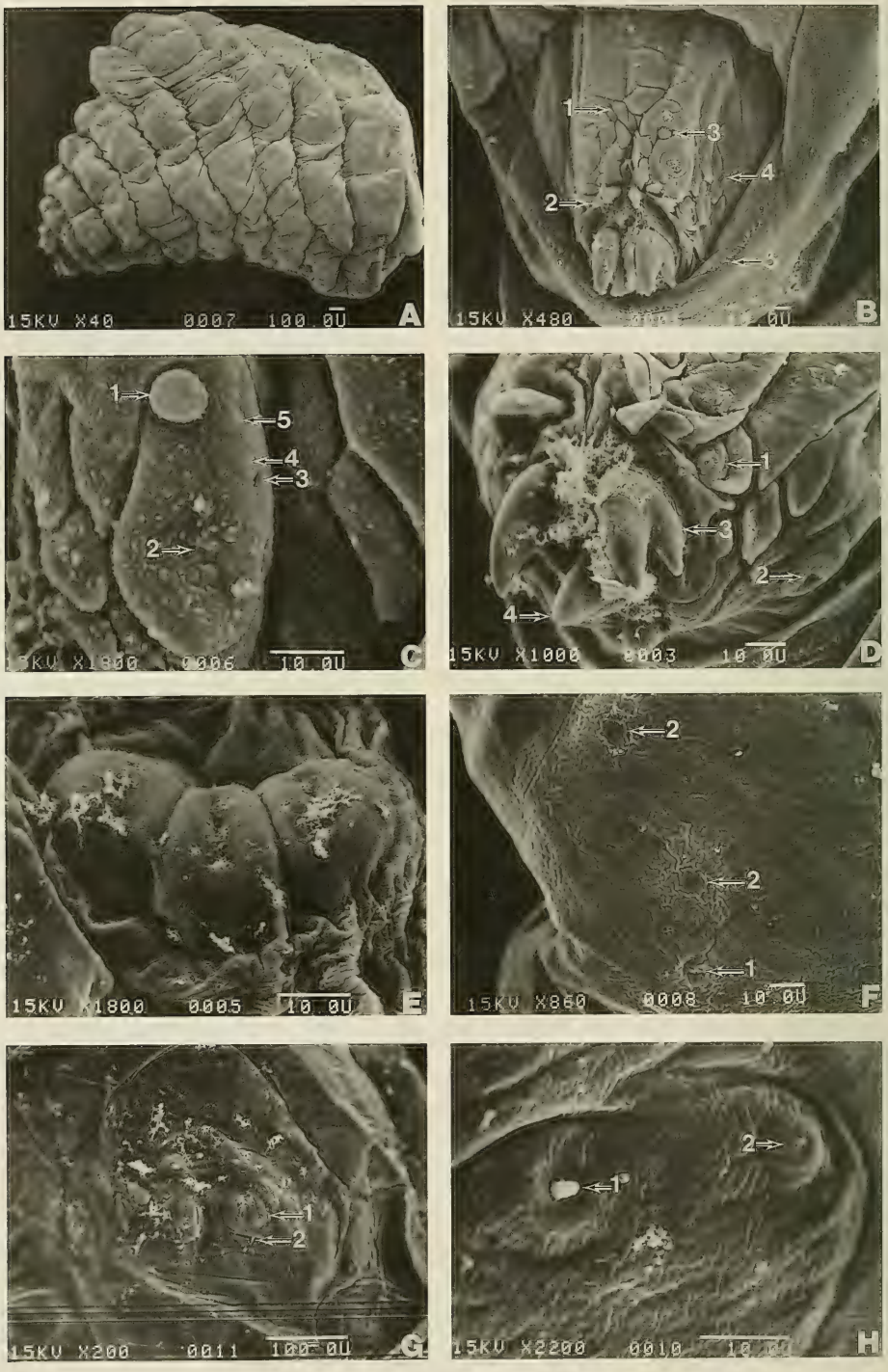

Fig. 2. Third instar of *A. semilucida*. (A) Habitus, anterior to left; (B) gnathocephalon, anterior view, 1—rugose pads, 2—elongated dorsal petals, 3—dorsal sensory organ, 4—lateral sensillum, 5—minute acanthae; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ; (D) gnathocephalon, ventrolateral view, 1—stomal sense organ,

ment of sensory structures. They do however, differ in the number of sensilla in the lateral spiracular complex. *Aciurina michaeli* has only one verruciform sensillum in the metathoracic lateral spiracular complex and no sensilla in the abdominal lateral spiracular complex (Goeden and Teerink 1996a). *Aciurina idahoensis* which co-occurs with *A. semilucida* on *C. viscidflorus,* has the same number of sensillum in the lateral spiracular complex as *A. michaeli.* (Goeden and Teerink 1996b).

Second instar: Superficially smooth, pyriform, minute acanthae ventrally (Fig. 3A); gnathocephalon conical, smooth, rugose pads mediad and laterad of anterior sensory lobes (Fig. 3B-1); dorsal petals dorsad of mouth lumen (Fig. 3B-2); paired dorsal sensory organs dorsomediad of anterior sensory lobes (Fig. 3B-3, 3C-1); anterior sensory lobes bear the terminal sensory organ (Fig. 3C-2), pit sensory organ (Fig. 3C-3), lateral sensory organ (Fig. 3C-4), and supralateral sensory organ (Fig. 3C-5); stomal sense organs ventrolaterad of anterior sensory lobes, near mouth lumen (Fig. 3B-4, 3C-6); mouth hooks bidentate, teeth conical (Fig. 3B-5); median oral lobe laterally flattened, tapering apically (Fig. 3B-6); prothorax smooth (Fig. 3B); anterior thoracic spiracles consist of three oval papillae (Fig. 3D); metathoracic lateral spiracular complex consists of an open spiracle (Fig. 3E-1), and two verruciform sensilla (Fig. 3E-2); abdominal lateral spiracular complex consists of an open spiracle and a single verruciform sensilla; caudal segment bears the posterior spiracular plates (Fig. 3F-1); posterior spiracular plates with three oval rimae, ca. 0.01 mm in length (Fig. 3G-1), and four blade-like interspiracular processes, longest measuring 0.008 mm (Fig. 3G-2); compound sensilla ventrad of posterior spiracular plates (Fig. 3F-2) consist of a stelex sensillum and a verruciform sensillum (Fig. 3H); stelex sensilla surround margin of caudal segment in 2-dorsal, 4-ventral arrangement (Fig. 3F-3).

The second instar is enlarged dorsally in abdominal segments III–V as in the third instar. The gnathocephalon is similar in shape and sensory structures. The anterior thoracic spiracles, lateral spiracular complex and the posterior spiracles are consistent between the two instars. The second instar differs slightly from the third in the compound sensilla on the caudal segment. One pair in the second instar consists only of a stelex sensillum. This was also observed in *A. idahoensis,* where the second instar contained only one sensillum in one of the compound sensilla (Goeden and Teerink 1996b); *A. ferruginea* also showed slight differences in the compound sensilla in the second and third instars (Goeden and Teerink 1996a).

First instar: Superficially smooth, ovoidal, minute acanthae circumscribe intersegmental lines; gnathocephalon conical, smooth (Fig. 4A); paired dorsal petals dorsad of mouth lumen (Fig. 4A-1); dorsal sensory organs dorsomediad of anterior sensory lobes (Fig. 4A-2, 4B-1); anterior sensory lobes bear the terminal sensory organ (Fig. 4B-2), pit sensory organ (not observed), lateral sensory organ (Fig. 4B-3), supralateral sensory organ (Fig. 4B-4); stomal sense organs indistinct, laterad of mouth lumen (Fig. 4A-3); mouth hooks bidentate, teeth conical (Fig. 4A-4); median oral lobe laterally flattened (Fig. 4A-5); prothorax smooth; anterior thoracic spiracles absent; lateral spiracular complex not observed; caudal segment obscured in SEM specimens.

The first instar is not expanded dorsally

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2—ventrolateral sensillum, 3—mouth hooks, 4—median oral lobe; (E) anterior thoracic spiracle; (F) metathorax, lateral spiracular complex, 1—spiracle, 2—verruciform sensilla; (G) caudal segment, posterior spiracular plates, 1—rima, 2—interspiracular process; (H) compound sensillum, 1—stelex sensillum, 2—verruciform sensillum.

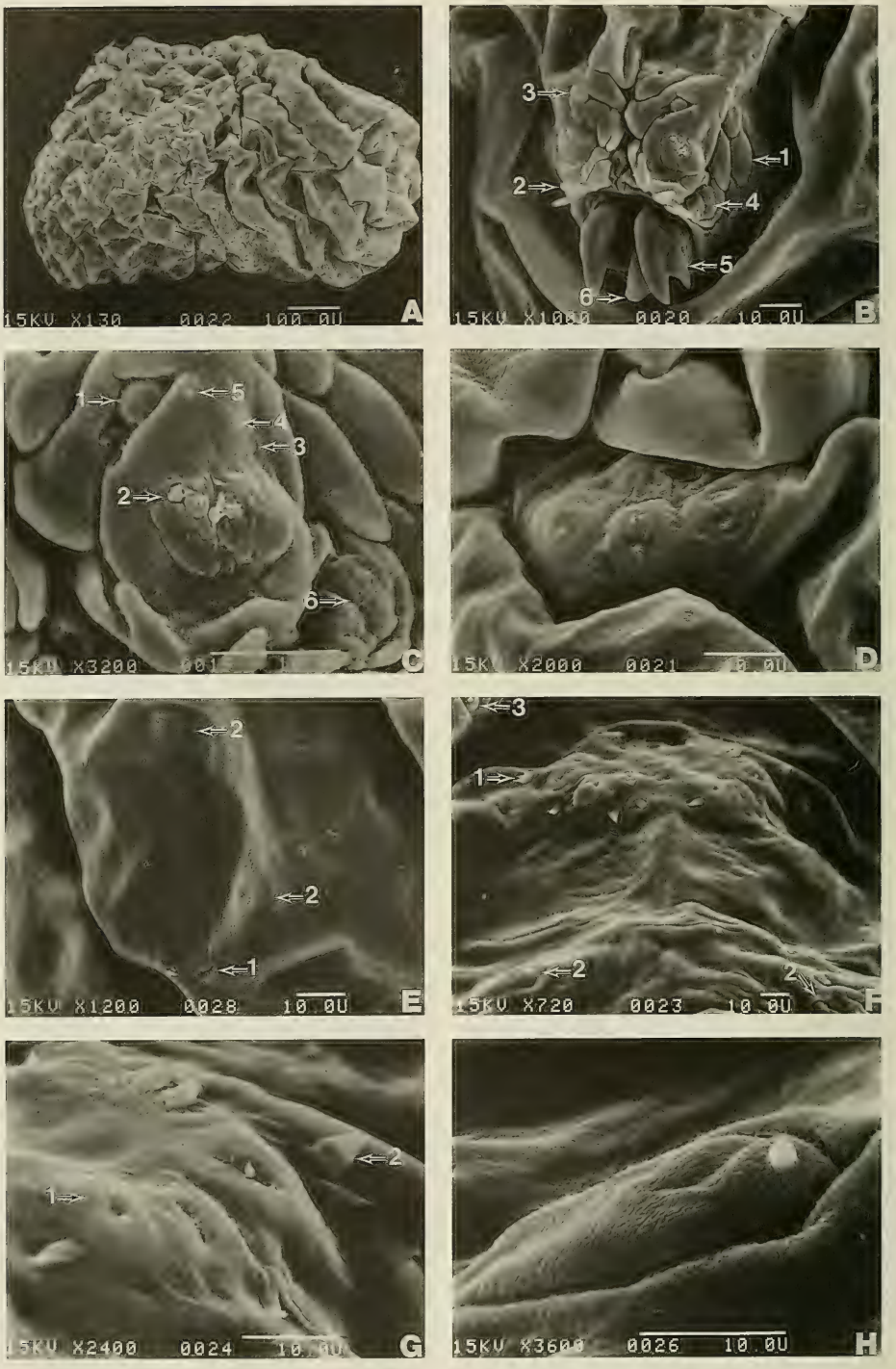

Fig. 3. Second instar of *A. semilucida*. (A) Habitus, anterior to left; (B) gnathocephalon, anterior view, 1—rugose pads, 2—dorsal petals, 3—dorsal sensory organ, 4—stomal sense organ, 5—mouth hooks, 6—median oral lobe; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ, 6—stomal sense organ; (D) anterior thoracic spiracle;

as in the third and second instars. The general habitus is more ovoid than pyriform. The gnathocephalon is smooth, lacking rugose pads. The anterior sensory lobes and stomal sense organs are small and indistinct. The gnathocephalon in *A. semilucida* first instars is similar to that of *A. ferruginea* and *A. idahoensis* (Goeden and Teerink 1996a, b).

Puparium: Smooth, elongate-reniform, reddish-brown (Fig. 5A); anterior end bears anterior thoracic spiracles (Fig. 5B-1) and invagination scar (Fig. 5B-2); caudal end bears posterior spiracular plates; posterior spiracular plates with three oval rimae, ca. 0.021 mm in length (Fig. 5C-1), and four interspiracular processes with 1–3 branches, longest measuring 0.01 mm (Fig. 5C-2). Nineteen averaged 3.94 ± 0.17 (range, 3.06–4.77) mm in length and 1.93 ± 0.07 (range, 1.44–2.34) mm in width.

Distribution and Hosts

Aciurina semilucida was known only from its type locality in Washington (Bates 1935) and from Nez Perce Co. in Idaho (Wangberg 1981). Although its distribution probably parallels those of its known host plants, *C. viscidiflorus* and *C. nauseosus,* both of which are common throughout the western United States (Munz 1974), it apparently exists in localized, discontinuous demes, whose semi-isolation probably facilitated the strong dimorphism at the southwestern periphery of its distribution in southern California reported herein. *Aciurina semilucida,* like *A. idahoensis,* has only been found in California at three locations in Deep Spring Valley, which lies close to the Nevada border. Alternatively, further taxonomic study of the galls, hosts, and reared *A. semilucida* adults from other locations in the western United States may ultimately show these southern and northern flies to be distinct and each to have specialized on only one of these two hosts, as apparently has happened in California with *A. ferruginea, A. michaeli* (Goeden and Teerink 1996a), *A. idahoensis* (Goeden and Teerink 1996b), and *A. semilucida* on *C. viscidiflorus* versus *A. trixa* on *C. nauseosus* in California (unpublished data). However, oligophagy is known among *Aciurina*

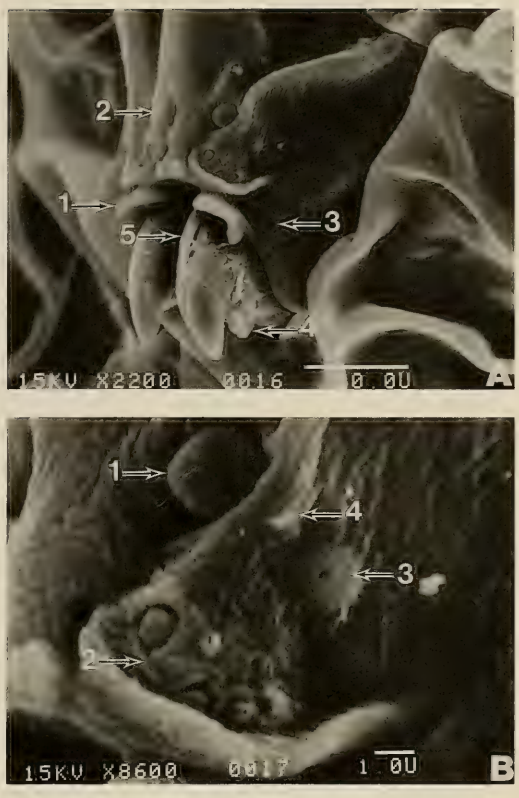

Fig. 4. First instar of *A. semilucida.* (A) Gnathocephalon, anterolateral view, 1—dorsal petals, 2—dorsal sensory organ, 3—stomal sense organ, 4—mouth hooks, 5—median oral lobe; (B) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—lateral sensory organ, 4—supralateral sensory organ.

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(E) metathorax, lateral spiracular complex, 1—spiracle, 2—verruciform sensilla; (F) caudal segment, 1—posterior spiracular plate, 2—compound sensilla, 3—stelex sensillum; (G) posterior spiracular plate, 1—rima, 2—interspiracular process; (H) compound sensillum, stelex sensillum.

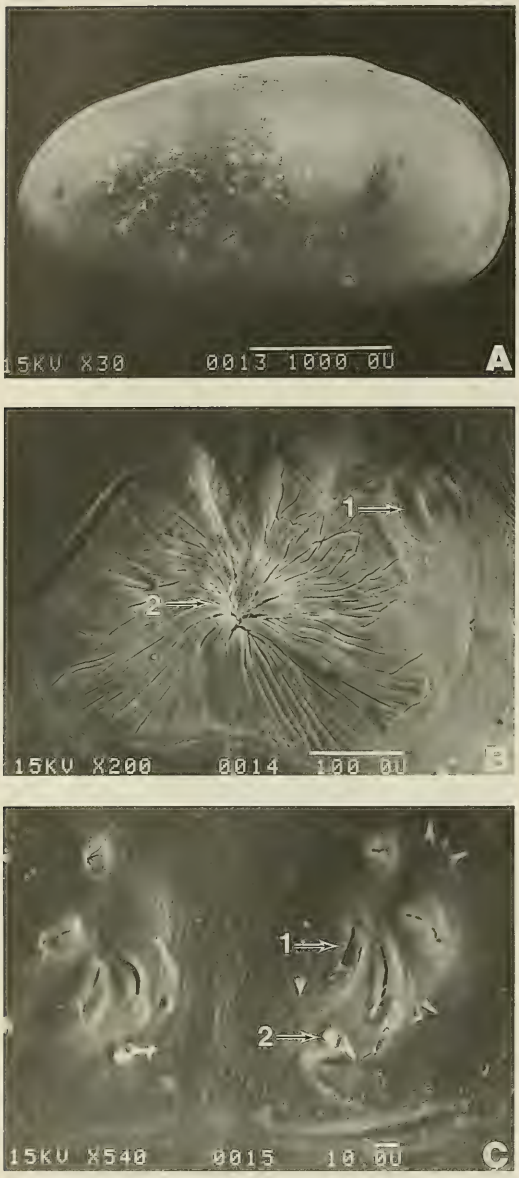

Fig. 5. Puparium of *A. semilucida.* (A) Habitus, anterior to left; (B) anterior end, 1—anterior thoracic spiracle, 2—invagination scar; (C) caudal segment, posterior spiracular plate, 1—rima, 2—interspiracular process.

spp. and confirmed for at least *A. thoracica* on *Baccharis* spp. in California (Headrick and Goeden 1993, RDG and JAT, unpublished data). Future resolution of this question of separate species status appropriately may also involve genetic techniques.

Biology

Egg.—Eggs are inserted singly in basal axillary buds of current year's branch growth (Fig. 6A), judging from the occurrence of only one larva per gall and the sessile nature of the gall, indicating little bud growth at the time of oviposition. The stalked eggs, like those of *A. idahoensis, A. ferruginea,* and *A. michaeli,* apparently are an adaptation for respiration in resin-covered buds of their mutual host plant (Goeden and Teerink 1996a, b). Detection of earliest stages of *Aciurina* spp. gall development and ascertaining whether eggs or young larvae are the overwintering stage(s) are difficult (Goeden and Teerink 1996a, b), and further complicated by the presence of at least four species of *Aciurina* and one species of *Procecidochares* (Diptera: Tephritidae) as well as Lepidoptera and Cecidomyiidae, all forming bud or branch galls on *C. viscidiflorus* (Wangberg 1980, 1981, Goeden and Teerink 1996a, b, unpublished data).

Larva.—The gall of *A. semilucida* is a stunted axillary branch, reminescent of the beaked galls of *A. michaeli* (Goeden and Teerink 1996a), but not as strongly attenuated or "beaked" apically (Fig. 6E, 6F). As such, they are dark green and subspheroidal when young (Fig. 6B, 6D), elongating and externally becoming pyriform in outline, light green, and pubescent as they grow and mature (Fig. 6E, 6F). They also bear several basally expanded, sessile, linear, smooth-margined leaves, which are shortest apically (Fig. 6E). The gall body is largely composed of whitish, spongy parenchymatous, expanded nodes, and a harder core surrounding the central locule (Fig. 6D, 6E); this description agrees with that of Wangberg (1981), which stated that, apparently including the epidermis, the galls are composed "of three distinct layers" (Fig. 6E). The gall is uniloculate (monothalmus) and characteristically contains an ovoidal to pyriform-shaped, central, open chamber within which the larva feeds by scraping

Fig. 6. Life stages of *A. semilucida* on *Chrysothamnus viscidiflorus* from California. (A) Egg in axillary bud; (B) axillary bud gall containing first instar; (C) saggital section of gall containing first instar; (D) saggital section of young gall with second instar in basal feeding chamber; (E) saggital section of gall with third instar; (F) full-size gall; (G) saggital section through full-size gall containing a puparium; (H) dorsal view of male; (I) dorsal view of female. Line = 1 mm.

away at the inner wall which becomes shallowly pitted (Fig. 6D, 6E). The photographic illustration in Wangberg (1981) shows the surface of the gall of *A. semilucida* as dull, not shiny, and thus more commensurate with pubescent, and what he termed "smooth." His photograph also better reflects what he described as its "ovoid," but not its alternative "tear-drop" shape. However, the 12 voucher specimens of galls attached to some of his reared specimens of *A. semilucida* on *C. nauseosus* from Idaho were, indeed, pubescent, slightly attenuated apicad, and bore shortened, basally expanded leaves more like the California galls described above (Fig. 6E, 6F). The galls of *A. semilucida* at our study sites externally also closely resembled the whitish gall of a gall midge (Diptera: Cecidomyiidae) also found on *C. viscidiflorus,* possibly *Asphondylia bigeloviae brassicoides* (Townsend) as described and illustrated by Gagné (1989).

Three dark-green galls containing first instars averaged 3.0 ± 0.7 (range, 2.2–4.5) mm in length and 2.2 ± 0.6 (range 1.6–3.4) mm in width (Fig. 6B, 6C). The gall cavities measured 1.4 ± 0.6 (range, 0.6–2.5) mm in length and 0.8 ± 0.3 (range, 0.4–1.4) mm in width (Fig. 6C). The gall walls averaged 0.28 ± 0.11 (range, 0.14–0.49) mm in greatest thickness.

Twenty-four galls containing second instars averaged 4.8 ± 0.4 (range, 2.8–9.7) mm in length and 2.6 ± 0.2 (range, 1.7–4.0) in width (Fig. 6D). The gall cavities measured 1.9 ± 0.1 (range, 0.6–3.4) mm in length by 1.1 ± 0.1 (range, 0.4–2.0) mm in width (Fig. 6D). The gall walls averaged 0.43 ± 0.04 (range, 0.14–0.98) mm in greatest thickness.

Forty-five galls containing third instars measured 8.3 ± 0.4 (range, 2.4–15) mm in length and 4.5 ± 0.1 (range, 2.3–6.3) mm in width (Fig. 6E), excluding the leaves. The elongated, ellipsoidal, central chamber averaged 4.1 ± 0.1 (range, 2.4–6.3) mm in length and 2.5 ± 0.1 (range, 1.4–3.8) mm in greatest width (Fig. 6E); the surrounding gall wall was 0.67 ± 0.04 (range, 0.28–1.14) mm wide at its thickest point (Fig. 6E). The dorsal abdominal projection or "hump" characteristic of third instars of *A. semilucida* (Fig. 2A) and *A. michaeli* (Goeden and Teerink 1996a), both species of which, as noted above, have similarly shaped galls with relatively large locules, apparently is an adaptation for locomotion within these open gall cavities, as first noted by Wangberg (1981) for the latter species (as *A. ferruginea*) and *A. maculata* (Cole). *Aciurina* spp. larvae developing in galls with small or narrow locules, e.g. *A. ferruginea* (Goeden and Teerink 1996a), *A. idahoensis* (Goeden and Teerink 1996b), and *A. thoracica* (Headrick and Goeden 1993), do not possess this dorsal ambulatory lobe.

Pupa.—Prior to pupariation, the fully formed third instar extends the apical end of the gall chamber to form an exit channel for the adult. The larva then pupariates with its anterior end facing this exit channel (Fig. 6G). Nineteen full-size galls containing puparia measured 9.8 ± 0.4 (range, 7.3–14) mm in length and 6.6 ± 0.2 (range, 5.0–8.0) mm in width (Fig. 6F, 6G). The pyriform central chamber averaged 5.7 ± 0.2 (range, 2.0–8.1) mm in length (including exit channel) and 3.3 ± 0.1 (range, 2.8–3.9) mm in greatest width (Fig. 6G); the surrounding gall wall was 1.39 ± 0.08 (range, 0.84–2.10) mm wide at its thickest point (Fig. 6G). This compares with mean greatest widths of 5.1 mm (range, 3.6–7.0 mm) for 20 galls reported by Wangberg (1981). Wangberg (1981) noted that the galls of *A. semilucida* on *C. nauseosus* were sticky to the touch, a characteristic not noted nor recorded independently by us, but entirely plausable, commensurate with the resinous nature of the buds and branches of *C. viscidiflorus* noted above and elsewhere (Goeden and Teerink 1996a, b). Otherwise, no biologically significant differences in the galls were detected to support separate species status for flies from California and Idaho.

Adult.—The adult emerges from the nar-

rowed apex of a gall by breaking through the thin epidermal window with the aid of its expanded ptilinum (Wangberg 1981). Newly emerged females contain fully-formed ova and their ovaries occupy most of their abdomens (Fig. 6I). In the insectary, three males lived 7, 12, and 31 days; two females, 3 and 11 days. Figures 6H and 6I further document the sexual dimorphic wing patterns of the males and females, respectively, in California.

Seasonal history.—Like *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996a), and *A. idahoensis* (Goeden and Teerink 1996b), *A. semilucida* is univoltine on its sole host plant, *C. viscidiflorus,* in California. These four species partition their host plant seasonally and altitudinally in California, with adults of *A. semilucida* and *A. idahoensis* emerging, mating, and ovipositing earlier in spring (May–June) at lower altitudes (<1800 m) than *A. ferruginea* and *A. michaeli,* which emerge, mate, and oviposit in summer (July–August) at higher elevations (>2100 m) (Goeden and Teerink 1996a, b). Adults and galls of all four *Aciurina* spp. have not been found together, only paired as reported from separate locations in California (Goeden and Teerink 1996a, b).

Wangberg (1981) reported finding galls containing third instars in late February and March, puparia in mid-March, April, and late-May, and adult emergence in late June. He suggested, therefore, that the third instar was the overwintering stage in Idaho. Conversely, our finding a total of one (1.6%) first instar, 17 (26.6%) second instars, and 46 (71.9%) third instars in galls sampled at all three study sites in Deep Spring Valley on 13.iv.1994 suggested to us that the overwintering stage was the first or second instar in California, probably the former, like *A. ferruginea* and *A. michaeli* (Goeden and Teerink 1996a).

Natural enemies.—Wangberg (1981) reported only two species of Hymenoptera associated with *A. semilucida* galls: *Tetrastichus cecidophagous* Wangberg (Eulophidae), an external larval parasitoid, and *Halticoptera* sp. (Pteromalidae) of unknown habits. We reared six females of *Halticoptera* sp. from puparia as solitary, primary endoparasitoids in our samples from California.

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EREMOCORIS DEPRESSUS BARBER: HOSTS, SEASONALITY, AND FIRST NEW ENGLAND RECORDS OF A PINE SEED SPECIALIST (HETEROPTERA: LYGAEIDAE)

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Abstract.—The rhyparochromine lygaeid *Eremocoris depressus* Barber should be considered a characteristic insect of northeastern pitch pine-scrub oak barrens. Known previously only as far north as southeastern Pennsylvania, this rarely collected species is reported from New York and New England (Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island). Other new records given are District of Columbia, Georgia, Texas, and West Virginia. New hosts recorded for this seed feeder are *Pinus palustris* Mill., *P. pungens* Lamb., *P. rigida* Mill., and *P. taeda* L. Notes on seasonal history and habits of this univoltine seed bug are provided.

Key Words: Insecta, seed bugs, distribution, pine barrens, host specialization

Eremocoris Fieber belongs to the tribe Drymini of the largest lygaeid subfamily, the Rhyparochrominae. Twelve species of this Holarctic genus are known from North America (an additional 9 species occur in Mexico; see Slater and O'Donnell 1995), four of which occur east of the Mississippi: *E. borealis* (Dallas), *E. depressus* Barber, *E. ferus* (Say), and *E. setosus* Blatchley (Ashlock and Slater 1988). *Eremocoris depressus* remains one of the least-studied eastern species of the genus. The adult, illustrated in Hoffman (1996), can be distinguished from its eastern congeners by the flattened body form and the nearly glabrous, uniformly dark (reddish brown to dark castaneous) hemelytra; some specimens are pale beige or bright tan (Slater and Baranowski 1990, Hoffman 1996).

Barber (1928) described *E. depressus* from Louisiana, Mississippi, New Jersey, North Carolina, and Virginia, noting it apparently is a southern species that ranges at least as far north as southern New Jersey. Since the original description, only South Carolina (Rainwater 1941), Florida (MacGowan 1988), and Pennsylvania (Slater and Baranowski 1990) have been cited as new state records. The Pennsylvania record, based on a specimen I collected during the present study (see "Distribution" below), became the northernmost known for the species. Hoffman (1996) provided additional locality records for Virginia. The Missouri record listed in Ashlock and A. Slater (1988) cannot be confirmed (J. A. Slater, personal communication 1992) and may have been cited in error.

For more than 60 years the only biological information available for *E. depressus* was limited to that reported in the original description: an association with Virginia pine (*Pinus virginiana* Mill.) in Virginia and an observation of an adult feeding on squash in Mississippi (Barber 1928). Independently, in Florida and Pennsylvania, its atypical habits were discovered. Instead of feeding on fallen seeds in the litter layer

like most rhyparochromines and nearly all other members of *Eremocoris* (Sweet 1964, 1977), *E. depressus* is arboreal, feeding on mature pine seeds still in the cones (Hoffman 1996). Slater and Baranowski (1990) reported its collection from cones of slash pine (*P. elliottii* Engelm.) in Florida and from pine cones in Pennsylvania. The Pennsylvania record, however, was based only on a single adult from pitch pine (*P. rigida* Mill.) rather than "numbers of specimens" as stated by Slater and Baranowski and clarified by Wheeler (1991a).

Here I give new records for *E. depressus,* extending the known distribution to northern New England. New host records, its occurrence in northeastern pitch pine-scrub oak barrens, and notes on its host plants and seasonal history are provided.

Methods and Study Sites

Most of the new records reported herein were obtained during a study of certain insect groups occurring in northeastern pitch pine-scrub oak barrens, ridgetop pine barrens, and other pitch pine communities (Wheeler 1991b, Wheeler and Wilson 1996). Several of the pine barrens from which *E. depressus* is recorded were described in Wheeler (1991b). Additional locality records are based on specimens in the National Museum of Natural History, Washington, DC (USNM), Pennsylvania Department of Agriculture collection (PADA), and Cornell University Insect Collection (CUIC); further information on the Oglethorpe Co., GA, and Sumter Co., SC, records (cited in brackets) was furnished by G. L. DeBarr (personal communication 1996). The sampling methods used in the Northeast were those described in my earlier study except that cones of pitch pine were emphasized—that is, cones, rather than host branches, were tapped over a shallow insect net.

Information on seasonality of *E. depressus* is based on five collections from pitch pines in the remnant pine barrens near the airport at Concord, NH, as well as on periodic collections from other pitch pine communities in the Northeast. Nymphs dislodged from pine cones were collected, preserved in 70% ethanol, and sorted to instar in the laboratory. Voucher specimens from northeastern pine barrens are deposited in the USNM collection.

Distribution

Present survey.—The following new records (Fig. 1) were obtained during a study of Miridae (Heteroptera) associated with pitch pine (Wheeler, unpublished); all are new state records except Pennsylvania, which was cited by Slater and Baranowski (1990), and New Jersey. Collections were made by the author from pitch pine except in West Virginia, where the host was table mountain pine (*P. pungens* Lamb.). Collections consisting only of nymphs are designated "(N)."

CONNECTICUT: *Windham Co.,* Windham Airport N. of Willimantic, 1 Sept. 1991 (N). MAINE: *Cumberland Co.,* Mayall Rd. N. of Gray, 14 Aug. 1993; *Oxford Co.,* Rt. 5-113 SE. of Fryeburg, 6 July 1991 (N), 19 June 1993; *York Co.,* Ferry Beach State Park nr. Saco, 14 Aug. 1993; Kennebunk Plains, 13 Aug. 1993. MASSACHUSETTS: *Franklin Co.,* Montague sand plains, 15 June (N), 4 July (N), 15 Sept. 1991. NEW HAMPSHIRE: *Carroll Co.,* Ossipee Pine Barrens, 2 June 1995; *Merrimack Co.,* Concord, 5 July (N), 12 Aug., 14 Sept. 1991; 19 June 1993; 2 June 1995. NEW JERSEY: *Ocean Co.,* Rt. 539 S. of Warren Grove, 22 June 1991 (N). NEW YORK: *Albany Co.,* Washington Ave. Ext., Albany, 22 Aug. 1993; *Clinton Co.,* Rt. 87, S. of Plattsburgh, 2 Aug. (N) & 29 Aug. 1992; 13 June 1993; *Saratoga Co.,* Saratoga Co. Airport nr. Ballston Spa, 1 Aug. (N) & 22 Aug. 1992; South Glens Falls, 1 Aug. 1992 (N); *Warren Co.,* Queensbury, Middle School, 30 Aug. 1992. PENNSYLVANIA: *Chester Co.,* Nottingham Co. Park, SW. of Nottingham, 27 Aug. 1988. RHODE ISLAND: *Washington Co.,* gravel pit along Rt. 165 nr. Arcadia Management

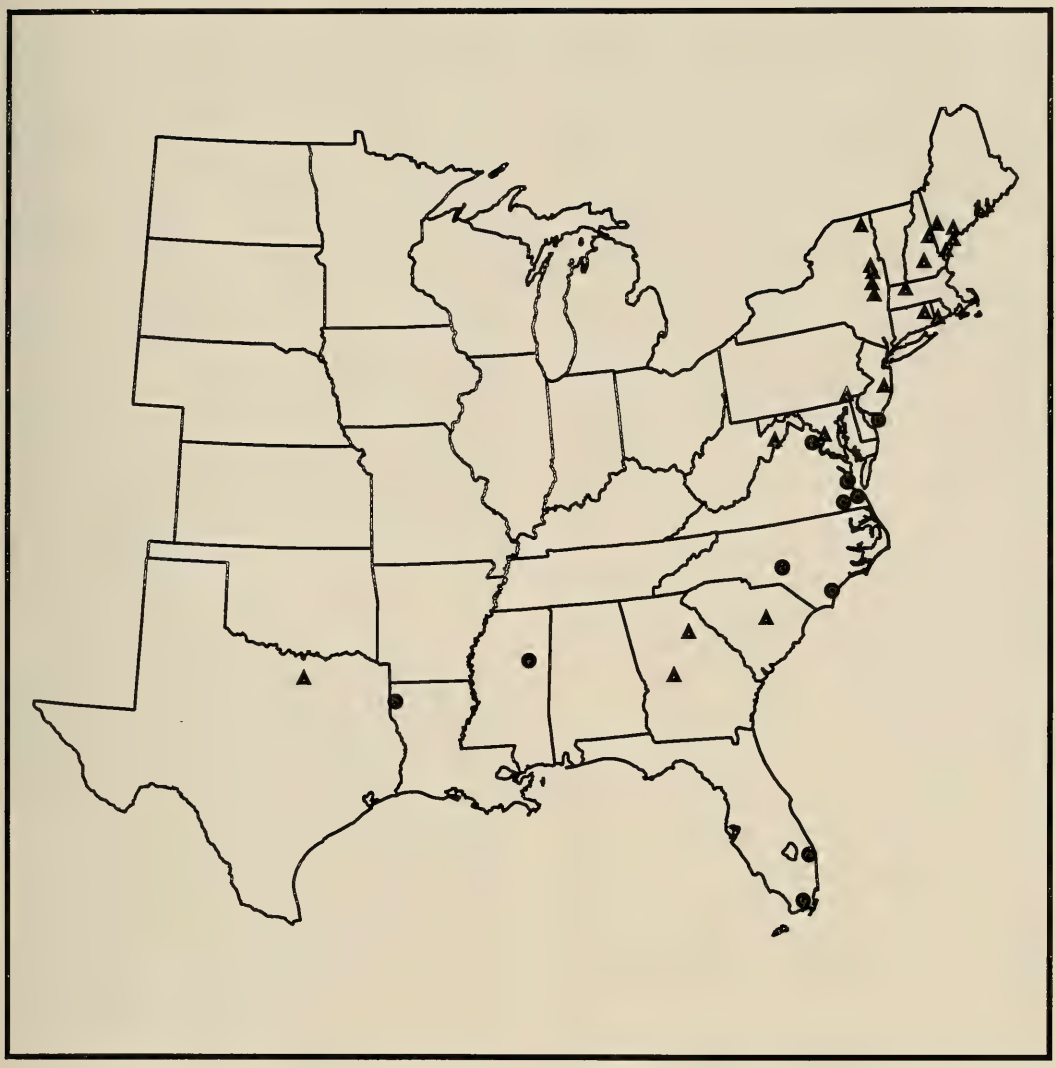

Fig. 1. Known distribution of *Eremocoris depressus*. Triangles= new records from author's surveys (West Virginia to Maine), including a Pennsylvania record published in Slater and Baranowski 1990, and from museum specimens (District of Columbia, Georgia, South Carolina, and Texas); filled circles = previously published records.

Area, N. of Arcadia, 7 July (N), 1 Sept. 1991 (N); 20 June 1993. WEST VIRGINIA: *Hardy Co.,* Lost River State Park Rd., 2.9 mi. N.W. of park, 27 Aug. 1993.

Museum records.—The following unpublished records (Fig. 1) were obtained from specimens housed in the CUIC, PADA, and USNM. Georgia, Texas, and the District of Columbia are new records.

DISTRICT of COLUMBIA: Washington, 10 Aug.; 15 Sept. on pine trees, O. Heidemann; 20 June 1884 (CUIC, USNM). GEORGIA: *Chatham Co.,* nr. Savannah, early Feb. 1983, in fallen *P. palustris* cone, J. R. Steinhauer (PADA); *Oglethorpe Co.* [5 mi. E. of Lexington], 19 May 1977 [ex cones of *P. taeda*], G. L. DeBarr (USNM); [*Peach Co.*] Myrtle, 28 Mar. 1906, on pear, A. A. Girault (USNM). VIRGINIA: [*Arlington Co.*] Rosslyn, 7 Apr. 1895, Chitten-

den (USNM). SOUTH CAROLINA: *Sumter Co.* [S. C. For. Commission seed orchard, nr. Sumter], 30 Sept. 1982 [abundant in cones of *P. taeda*], G. L. DeBarr (USNM). TEXAS: [*Denton Co.*] Denton, 28 May 1906, F. C. Bishop (USNM).

Seasonal History and Habits

Although no adults of *E. depressus* were collected from pitch pines before early June, records of adults from January to early April in the more southern portion of its range indicate that this stage overwinters (Barber 1928, Hoffman 1996, PADA and USNM collections). Adults may hibernate among ground litter, a possibility supported by their collection in "woods trash" during winter (Rainwater 1941), and the adult in February from a fallen longleaf pine cone near Savannah, Ga. (See "Distribution"). It is also possible that some adults overwinter in cones or under bark on host trees.

Overwintered adults were generally present on pitch pines through the end of June in the Northeast. Nymphs were not encountered before mid-June, but the presence of first through third instars at Concord, NH, on 19 June, a second instar in Rhode Island on 20 June, and a fourth instar in the Montague (MA) sand plains on 15 June suggests that eggs hatch at least as early as late May or early June in some inland and coastal pine barrens of New England. Nymphs were always associated with second-year, partially opened cones of pitch pine rather than current-season cones or third-year and older cones that persisted on host trees. My collections were made only from cones within reach of the ground, but observations in Georgia and South Carolina indicate that this lygaeid also lives in cones in the canopy of loblolly pine (G. L. DeBarr, personal communication 1996)

Fourth and fifth instars were collected in northeastern pine barrens by early July, but their development apparently proceeds slowly. Current-season adults were not observed before mid-August; all early August collections consisted entirely of late-instar nymphs, which were sometimes present until late August or early September. Because sampling was limited after mid-September, it is not known how long adults of this apparently univoltine lygaeid remain on host trees.

From southern New Jersey to northern New England, *E. depressus* has been found only on pitch pine. Farther south, it has been collected on loblolly pine, slash pine, table mountain pine, and Virginia pine (Barber 1928, Slater and Baranowski 1990, USNM collection). Its recovery in a pitfall trap in a longleaf pine barren in Virginia (Hoffman 1996) and a fallen longleaf pine cone in Georgia (PADA collection) suggest that *P. palustris* Mill. also serves as a host plant.

Discussion

Originally described as a southern species (Barber 1928) and subsequently considered to exhibit a southeastern (Sweet 1977) or a lower Austral range (Hoffman 1996), *E. depressus* can now be added to the New England fauna. An arboreal habit almost certainly accounts for its having gone undetected in Sweet's (1964) thorough survey of the New England rhyparochromine fauna; his collecting was restricted to the "cryptic ground level biotope." In Sweet's analysis of lygaeid distribution patterns, *E. depressus* roughly corresponds to a type 2 Austral range. Known from southwestern Maine, it ranges south, mainly along the coastal plain, to Florida, and west along the Gulf Coast to Louisiana and eastern Texas (see Fig. 1). The northernmost collection site is just south of Plattsburgh, N.Y. It was found at elevations ranging from near sea level at Maine's Ferry Beach State Park to about 853 m (2800 ft.) on a ridgetop in West Virginia.

In the Northeast, *E. depressus* is a characteristic, though usually uncommon, inhabitant of different types of pine barrens communities. In Maine, it has been found on a pitch pine near the lowland and ridgetop pine barrens at Fryeburg and in the

largely remnant pitch pine-scrub oak barrens in the Kennebunk Plains. This lygaeid also occurs in the boreal Ossipee Pine Barrens in New Hampshire; in several midlatitude inland pine barrens, including the degraded barrens at Concord, NH, New York's Albany Pine Bush, and the Montague sand plains in Massachusetts; near the Arcadia Management Area, a coastal pine barrens in Rhode Island; and in the New Jersey Pine Barrens. The only Pennsylvania record was from pitch pine in the Nottingham Park serpentine barrens.

Despite its wide range in the Northeast, *E. depressus* is patchily distributed, often occurring in edaphic "islands" that differ from surrounding areas in having nutrient-poor, excessively drained soil and generally higher fire frequency. At Fryeburg, ME, Concord, NH, and Albany, NY, it was a species of "urban forests" (e.g. McBride and Jacobs 1976), occurring on remnant pitch pines amid commercial development and suburban sprawl.

This pine seed specialist may have been widespread in the Northeast before the Pleistocene glaciations. During the glacial period, jack pine (*P. banksiana* Lamb.) and pitch pine survived in refugia along the Atlantic coastal plain east and south of the ice sheets (see Slater et al. 1993). It is likely that *E. depressus* also survived in such glacial refugia. When the climate warmed, this lygaeid migrated northward along the coastal plain, following the slow migration of pitch pine into once-glaciated areas. Pine barrens apparently reached their maximum during the Hypsithermal Interval, about 8,000 years before present, when the climate was much drier and warmer. With a return to wetter, cooler conditions, the extent of pitch pine-scrub oak barrens was reduced; some of these once-continuous communities became isolated (Cryan 1985). In addition, land development, fire suppression, and other types of anthropogenic influences have adversely affected pine barrens and likely have further fragmented the range of *E. depressus* on pitch pine in the Northeast.

Some cones of both pitch pine and jack pine are serotinous, remaining closed after maturity until exposed to high temperature. This polymorphism is an adaptation to fire in disclimax communities, allowing seed to be shed under conditions most favorable for regeneration (Ledig and Little 1979). Slater et al. (1993) speculated that cone serotiny may have promoted the arboreal niche of another pine-restricted rhyparochromine, *Slaterobius quadristriatus* (Barber), by extending seed retention. *Eremocoris depressus,* however, develops in the Northeast on pitch pines bearing nonserotinous or open cones.

The rarely collected *S. quadristriatus* uses pitch pine as its host in the New Jersey Pine Barrens, but it develops on jack pine in the Great Lakes region (Slater et al. 1993). A similar pattern of host use may also prevail in another seldom-collected pine cone specialist, the cerambycid *Xylotrechus schaefferi* Schott (Hoebeke and Huether 1990). My attempts to collect *E. depressus* on jack pine have been unsuccessful: in Clinton County, NY, near known populations of this bug on pitch pine, as well as in Michigan and Minnesota. Because of this lygaeid's spotty distribution and the difficulty of detecting populations in cones, more intensive sampling may eventually result in its collection from jack pine.

In the southern states, *E. depressus* is associated with several economically important pine species. This lygaeid can be added to the small number of heteropterans known to feed on mature seeds of North American pines. The importance of rhyparochromines as predators of seeds on plants and of fallen seeds in the litter layer is generally underestimated because their feeding does not produce dramatic symptoms; they make nearly invisible holes in seeds (Sweet 1964, 1977). Yet, among heteropterans that feed on pine seeds, any importance of *E. depressus* in seed orchards of the South is pre-

sumably much less than that of the scutellerid *Tetyra bipunctata* (Herrich-Schaeffer) or species belonging to the coreid genus *Leptoglossus* (see Hedlin et al. 1981).

Eremocoris depressus differs from nearly all other rhyparochromine lygaeids not only in its arboreal habits but also its restriction to a single plant genus (Sweet 1964). Even though nymphs develop only on pines, adults are occasionally observed on other plants (Barber 1928, USNM collection), perhaps the result of posthibernation dispersal (Sweet 1964). Within *Eremocoris,* arboreal habits and the flattened body form are certainly derived characters; a similar example in the Rhyparochrominae (Ozophorini) is *Ozophora hohenbergia* Slater & Baranowski, a dorsoventrally flattened, arboreal member of an otherwise litter-inhabiting genus (Slater and Baranowski 1978). Nearly all other North American species of *Eremocoris* are litter inhabitants that show a preference for conifer seeds (Sweet 1964, 1977). But *Eremocoris cupressicola* Ashlock lives in cypress trees in California, apparently feeding on seeds in open cones (Ashlock 1979). Unlike the brachypterous *E. cupressicola, E. depressus* is macropterous. Selection tends to favor flight capability in arboreal Hemiptera because of the architectural complexity or three dimensionality of the habitat (Slater 1977, Waloff 1983, Denno 1994, Schuh and Slater 1995). Flight would also seem advantageous in fire disclimax communities such as pitch pine-scrub oak barrens.

Eremocoris depressus is further atypical of most other New England rhyparochromines in its seasonality. Adults of this univoltine species appear late in the season, usually not until mid-August or early September. Although details of the seasonal history remain unknown, *E. depressus* most closely resembles *Scolopostethus atlanticus* Horvath in its seasonality. In the New England fauna, *S. atlanticus* is also a late-maturing, univoltine species whose nymphal development is prolonged over most of the summer (Sweet 1964).

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NEW SPECIES OF PHYCITINAE (LEPIDOPTERA: PYRALIDAE) FROM THE DOMINICAN REPUBLIC

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Abstract.—Fourteen **new species** of phycitines collected in the Dominican Republic are described. They are: ***Chararica circiimperfecta, Aptunga setadebilia, Aptunga vega, Aptunga culmenicola, Moodna antilleana, Caudellia pilosa, Varneria albiornatella, Ozamia plagata, Dioryctria postmajorella, Dioryctria dominguensis, Dasypyga independencia, Lascelina pedernalensis, Zamagiria rawlinsi,*** and ***Caristanius tripartitus.***

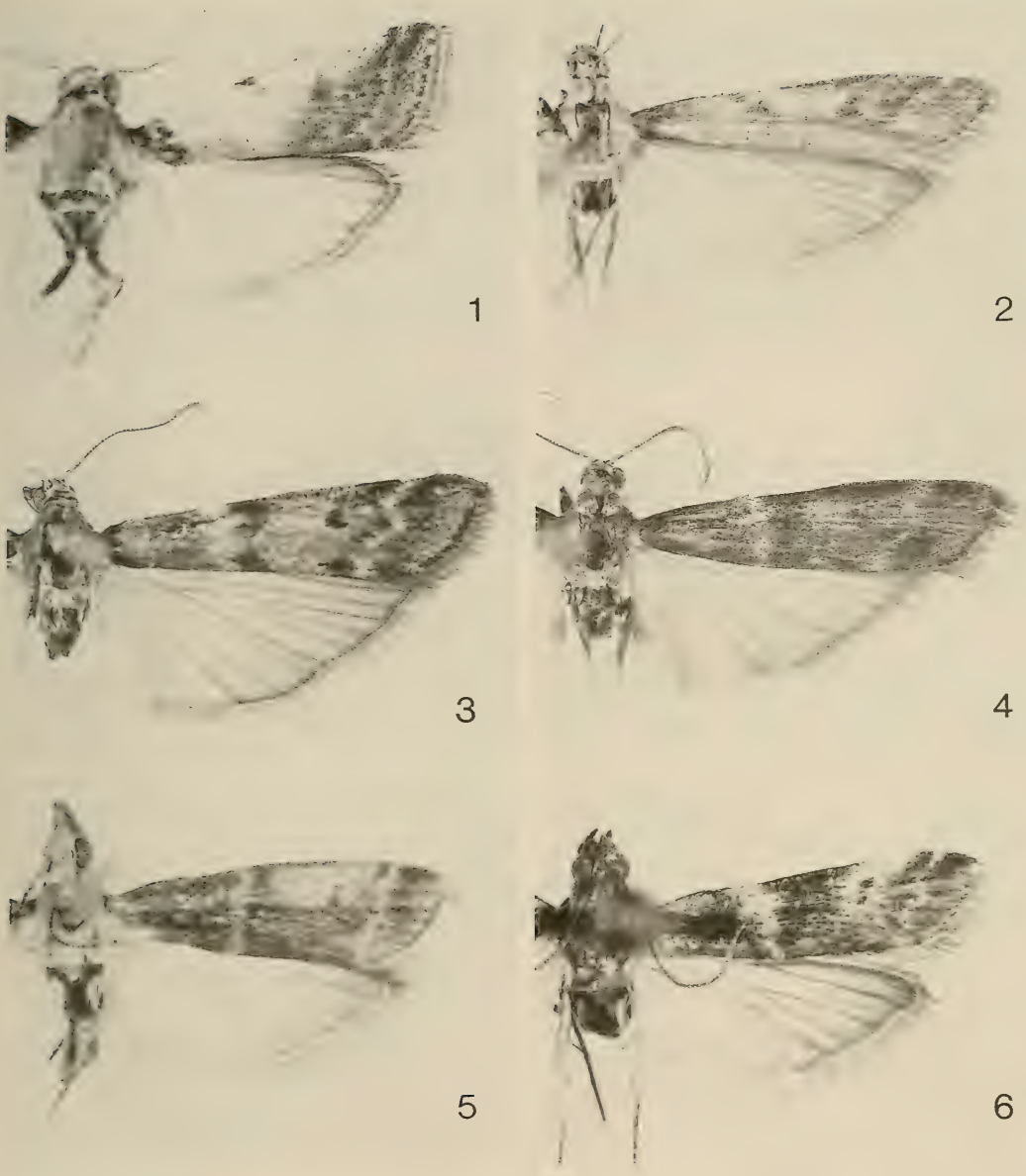
Key Words: moths, Pyralidae, Dominican Republic

In 1956 Heinrich revised the American Phycitinae and recognized nine species as occurring in the Dominican Republic. An examination of more recently collected specimens of Dominican Republic phycitines in the National Museum of Natural History (USNM) and the Carnegie Museum of Natural History (CMNH) has established that many additional Phycitinae occur in this Caribbean country. This paper provides names for undescribed species found during the process of studying the newer material. A subsequent publication will consist of an annotated list of other Dominican Republic phycitines recently acquired by the USNM and CMNH.

The USNM material was obtained at lights at a total of 15 sites located at low to moderate elevations mostly in the west and central provinces in 1969, 1973, and 1981, during May and June. The CMNH phycitines were light-trapped at 52 locations that sampled the east, west, north, south and central parts of the country and included elevations ranging from sea level to montane sites exceeding 2300 meters above sea level during 1987, 1990, 1991 and 1992 in July, August, September, October and November. C. Covell (C.), D. and M. Davis (D. & D.), and O. Flint and L. Gomez (F. & G.) collected the USNM material; R. Davidson (D.), M. Klingler (K.), J. Rawlins (R.), S. Thompson (T.) and C. Young (Y.) collected the CMNH material.

The highest mountains in the Caribbean are found in the Dominican Republic. The Cordillera Central is 2000 meters above sea level near the Haitian border and reaches a height of 3087 meters at Pico Duarte. Rainfall is substantial in some regions and very limited in other areas. The flora is rich in diversity, and a large number of endemic species occur in the Republic. Liogier (1981) estimated that 36% of the plants in the Dominican Republic are endemics. Moscoso (1943) provided a general treatment of the flora, as well as a map showing the amount of rainfall that usually occurs in various parts of the country.

All holotypes and most paratypes of new species are deposited in the USNM and the CMNH. A few paratypes are in the North Carolina State University Insect Collection (NCSU).



Figs. 1–6. Male adults. 1, *Chararica circiimperfecta,* holotype (7.0 mm). 2, *Aptunga setadebilia,* holotype (9.0 mm). 3, *Aptunga vega,* holotype (13.0 mm). 4, *Aptunga culmenicola,* holotype (12.5 mm). 5, *Moodna antilleana,* holotype (6.5 mm). 6, *Caudellia pilosa,* holotype (6.0 mm). (Length of forewing in parentheses.)

***Chararica circiimperfecta* Neunzig new species**

(Figs. 1, 15–17, 23)

Type locality.—Independencia, 4 km S Los Pinos, Loma de Vientos (18-35N, 71-46W), 475 m, Dominican Republic.

Diagnosis.—Although moths of *C. circiimperfecta* resemble those of *Chararica hystriculella* (Hulst), the transtilla differs greatly in the two species. In *C. circiimperfecta* this structure is weakly developed, lacking medial elements and having

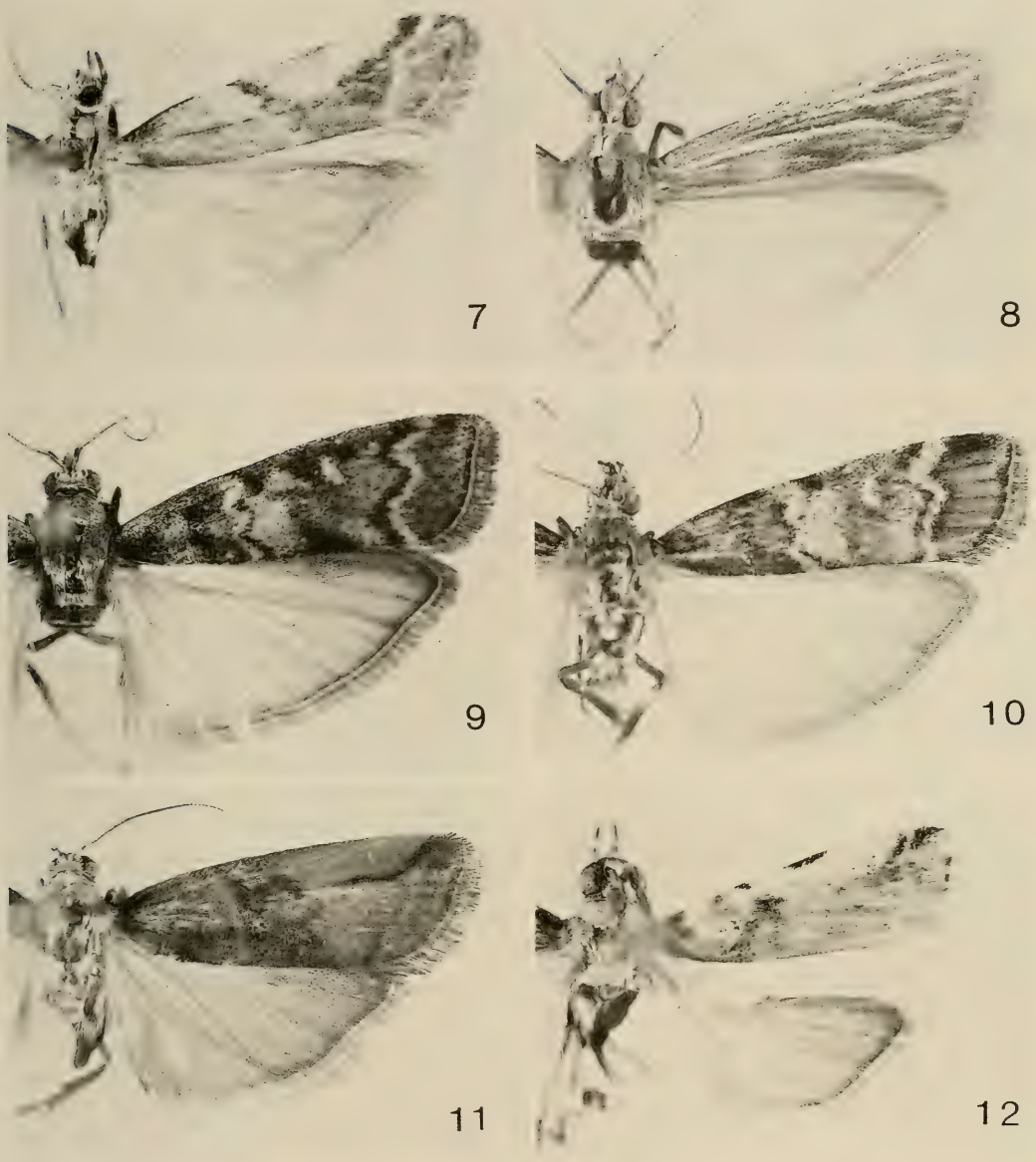
only short seta-bearing arms, whereas in *C. hystriculella* the transtilla has well developed, medially directed elements and the seta-bearing arms are long with the setae reaching, or almost reaching, the base of the uncus. The juxta of the two species also differs in that in *C. circiimperfecta* the lateral arms are shorter than in *C. hystriculella* and the associated setae are all on the distal half of the arms; the longer lateral arms of the juxta of *hystriculella* have setae on the basal as well as the distal half of the arms.

Description.—Length of forewing 7.0–8.0 mm. Head with frons smoothly scaled, pale fuscous and white; vertex fuscous and black, sometimes with reddish brown, white to brown or reddish brown between antennae; male and female antenna simple; labial palpus of both sexes curved upward (Fig. 23), mostly fuscous and black, basal segment generally dusted with white, other segments with a few white scales, mostly distally; maxillary palpus of both sexes with scaling aigrettelike, mostly fuscous and black and dusted with white. Thorax dorsum and collar fuscous, black and pale, to dark, reddish brown. Forewing with ground color fuscous to black; heavily overlaid with white on most of costal half and most of proximal part of posterior half (base of wing dark); antemedial line indistinguishable, blending with white of wing, its location partially delineated by thin (except at costa), incomplete, black line; postmedial line weakly formed, white; some indistinct red or brownish red scales sometimes generally distributed, or forming vague patches, on wing; discal spots moderately distinct, not clearly forming distinctive orbicular mark of other *Chararica*; underside of wing of male without costal fold and sex-scaling. Hindwing very pale fuscous, almost hyaline, darker near wing margins. Lateral thoracic sclerite of male with penicillus. Male abdominal segment 8 with paired ventrolateral scale tufts. Male genitalia (Figs. 15, 16) with uncus strongly tapered and slender distally; gnathos weak, lacking central projection; transtilla without medial elements, with widely spaced, short, lateral arms bearing clusters of setae; juxta platelike with rather short lateral lobes bearing setae distally; valva very broad, costa noticeably arched mesially, outer margin broadly rounded; vinculum shorter than greatest width; aedoeagus with lateral margins serrate toward apex. Female genitalia (Fig. 17) with ductus bursae short, less than half as long as corpus bursae, sclerotized, with lateral, transverse wrinkles in posterior half; ostium bursae with pair of lateral pocketlike elements along anterior margin; corpus bursae membranous with signum a scobinate, invaginated cup; numerous scobinations surrounding signum; ductus seminalis from corpus bursae near its junction with ductus bursae.

Material examined.—♂ (holotype), Independencia, 4 km S Los Pinos, Loma de Vientos (18-35N, 71-46W), 475 m, semiarid deciduous forest with pastures, 12 October 1991, D. Y. T. R., genitalia slide 3653 HHN; 1 ♂ (paratype), same collection data; 1 ♂ (paratype), Pedernales, 9.5 km N Cabo Rojo (18-02N, 71-39W), 35 m, 19 July 1990, R. Y. T., genitalia slide 3782 HHN; 2 ♀ (paratypes), Monti Cristi, 5 km NNE Botoncillo (19-46N, 71-24W), 50 m, arid thornscrub, 29–30 November 1992, D. K. T. R., genitalia slide 3654 HHN.

Discussion.—This is the only record of the genus *Chararica* occurring outside the United States; however, it is likely that at least one species also occurs in Mexico (Neunzig 1990). Based on *Chararica* moths previously collected, the genus appears to be restricted to arid sites; the label information on the Dominican Republic moths supports this view.

Etymology.—The lack of clearly delineated orbicular, discal marks on the forewing, a distinguishing feature of other *Chararica*, has suggested the name *circiimperfecta* for this species.



Figs. 7–12. Male adults. 7, *Varneria albiornatella,* holotype (8.0 mm). 8, *Ozamia plagata,* holotype (10.5 mm). 9, *Dioryctria postmajorella,* holotype (14.0 mm). 10, *Dioryctria dominguensis,* holotype (14.0 mm). 11, *Dasypyga independencia,* holotype (11.0 mm). 12, *Lascelina pedernalensis,* holotype (6.5 mm). (Length of forewing in parentheses.)

Aptunga setadebilia Neunzig, new species

(Figs. 2, 18–21)

Type locality.—La Vega, 18 km SE Constanza (18-46N, 70-39W), 2310 m, Dominican Republic.

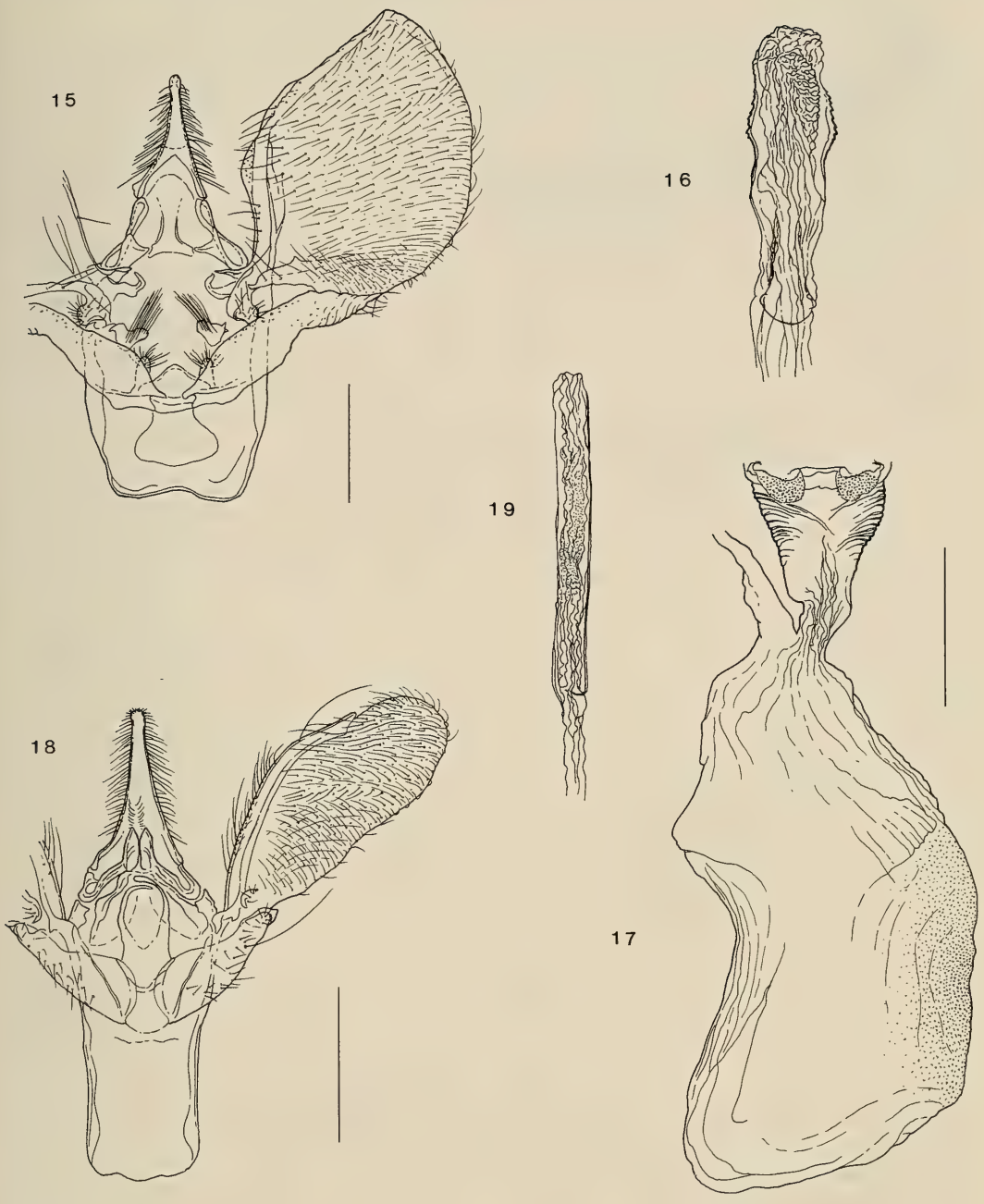
Diagnosis.—*A. setadebilia* has the following combination of features: forewing narrowly elongate with CuA_1 and CuA_2 approximate at base, and with indistinct to moderately well developed antemedial and postmedial lines; male genitalia with uncus

Figs. 13, 14. Male adults. 13, *Zamagiria rawlinsi,* holotype (11.5 mm). 14, *Caristanius tripartitus,* holotype (10.0 mm). (Length of forewing in parentheses.)

distally attenuated; female genitalia with unsclerotized corpus bursae, without signum. The species is easily separated from its nearest relative, *Aptunga macropasa* (Dyar), in that, in the male, abdominal segment 8 of *A. setadebilia* has weakly formed, indistinct scale tufts rather than strongly developed tufts.

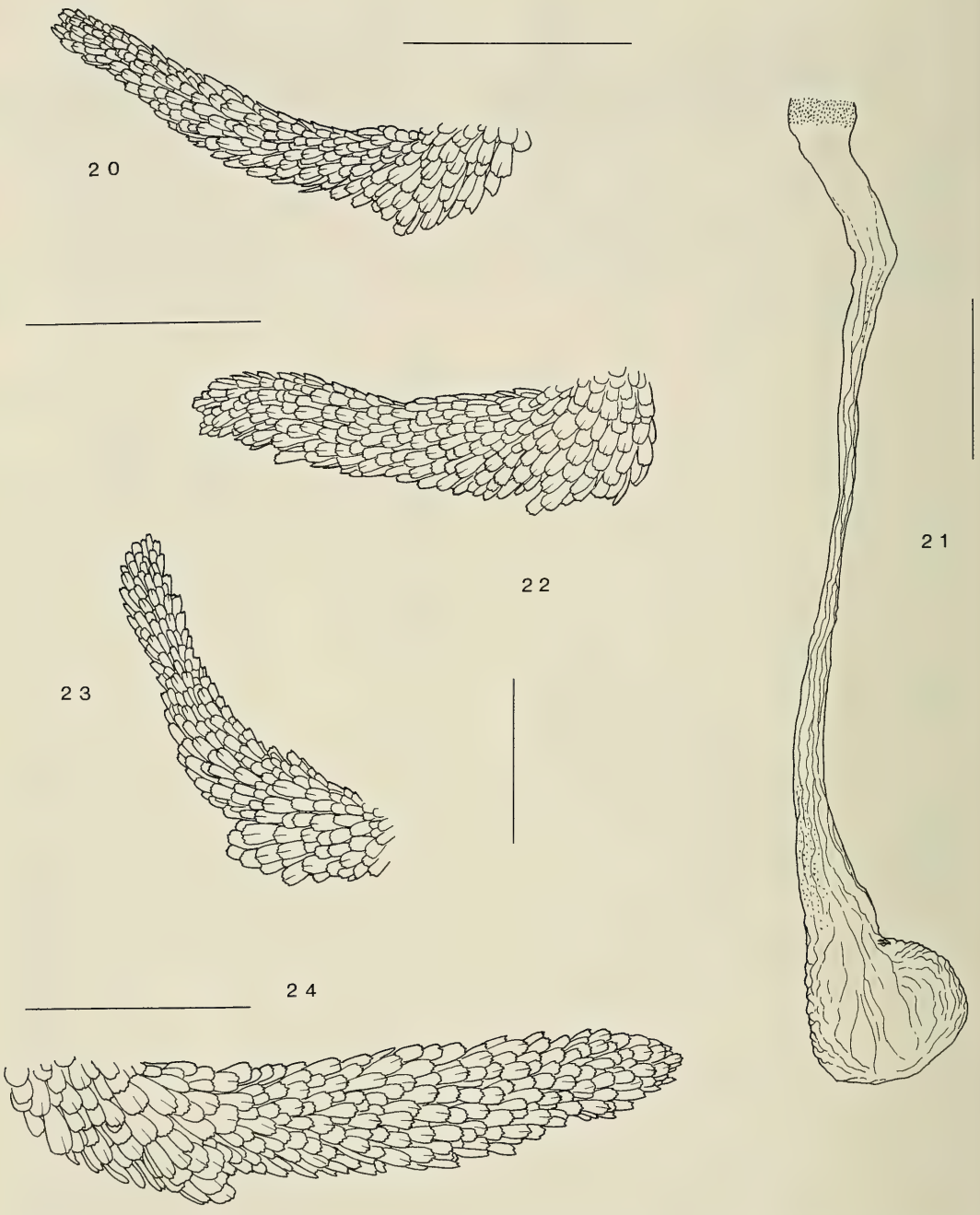
Description.—Length of forewing 8.5–9.0 mm. Head with frons with white-tipped, pale fuscous scales; vertex similar to frons but whiter, particularly near base of antenna; male and female antenna simple; labial palpus (Fig. 20) oblique; rather long, extending well beyond head in both sexes, basal segment mostly white with some fuscous, 2nd and 3rd segments fuscous with white distally; maxillary palpus fuscous, simple in both sexes. Thorax collar and dorsum pale fuscous to fuscous with many scales tipped with white. Forewing with fuscous ground color; antemedial line indistinct to moderately well developed, white; postmedial line indistinct to moderately well developed, white; basal, subbasal, medial and terminal areas moderately dusted with white and with varying amounts of red or pale reddish brown scales generally dispersed or forming vague patches; discal spots moderately well developed, black; underside of wing of male without costal fold and sex-scaling. Hindwing pale fuscous, darker along veins and near costal and outer margins. Male abdominal segment 8 with weakly formed scale tufts. Male genitalia (Figs. 18, 19) with uncus subtriangular, tapering abruptly, apical half narrow, bluntly pointed; gnathos with apical part divided into two, mostly parallel-sided elements; transtilla incomplete, represented by pair of separated, somewhat triangular, plates; juxta platelike with elongate lateral arms that extend posteriorly to base of apical elements of gnathos; valva rather simple, with strongly sclerotized costal band for about 3/4 its length; apex of costal band pointed and projecting very slightly free of valva, vinculum slightly longer than greatest width; aedoeagus slender and simple. Female genitalia (Fig. 21) with ductus bursae membranous, long and very slender, with band of scobinations near ostium bursae, and weak patch of scobinations near junction with corpus bursae; corpus bursae membranous, short and ovoid with faint signum composed of two small, pointed plates; ductus seminalis attached near middle of corpus bursae.

Material examined.—♂ (holotype), La Vega, 18 km SE Constanza (18-46N, 70-39W), 2310 m, pine woodland near head of small canyon, 25 November 1992, K. R. D. T., genitalia slide 3637 HHN; 2 ♂, 1 ♀ (paratypes), same collection data, genitalia



Figs. 15–19. Male and female genitalia. 15, *Chararica circiimperfecta,* aedoeagus omitted. 16, *C. circiimperfecta,* aedoeagus. 17, *C. circiimperfecta,* ductus bursae, corpus bursae and anterior part of ductus seminalis. 18, *Aptunga setadebilia,* aedoeagus omitted. 19, *A. setadebilia,* aedoeagus. (All scale lengths 0.5 mm.)

slide 3780 HHN; 1 ♀ (paratype), Pedernales, 5 km NE Los Arroyos (18-15N, 71-45W), 1680 m, cloud forest, 30 September 1991, D. Y. T. R., genitalia slide 3638 HHN; 1 ♀ (paratype), Peravia, 3 km SW La Nuez, Upper Rio Las Cuevas (18-39N, 70-36W), 1880 m, cloud forest on river, 5–6 October 1991, R. D. Y. T.



Figs. 20–24. Labial palpi and female genitalia. 20, *Aptunga setadebilia,* palpus. 21, *A. setadebilia,* ductus bursae and corpus bursae. 22, *A. culmenicola,* palpus. 23, *Chararica circiimperfecta,* palpus. 24, *Aptunga vega,* palpus. (All scale lengths 0.5 mm.)

Discussion.—Species in *Aptunga* appear to be restricted to relatively high elevation, mountainous sites. The Guatemalan and Mexican species, *A. macropasa,* has been reported from Purulhá, Chejel, Volcán Santa Maria and Orizaba (Heinrich, 1956). In the Dominican Republic, the three species of *Aptunga* described in this paper were collected at elevations of 1680 to 2310 m.

Etymology.—The specific epithet *setadebilia* is a combination of the Latin noun *seta,* meaning bristle, and the Latin adjective *debilis,* meaning weak, in allusion to the weakly formed scale tufts on the 8th abdominal segment.

Aptunga vega Neunzig, new species
(Figs. 3, 24–27)

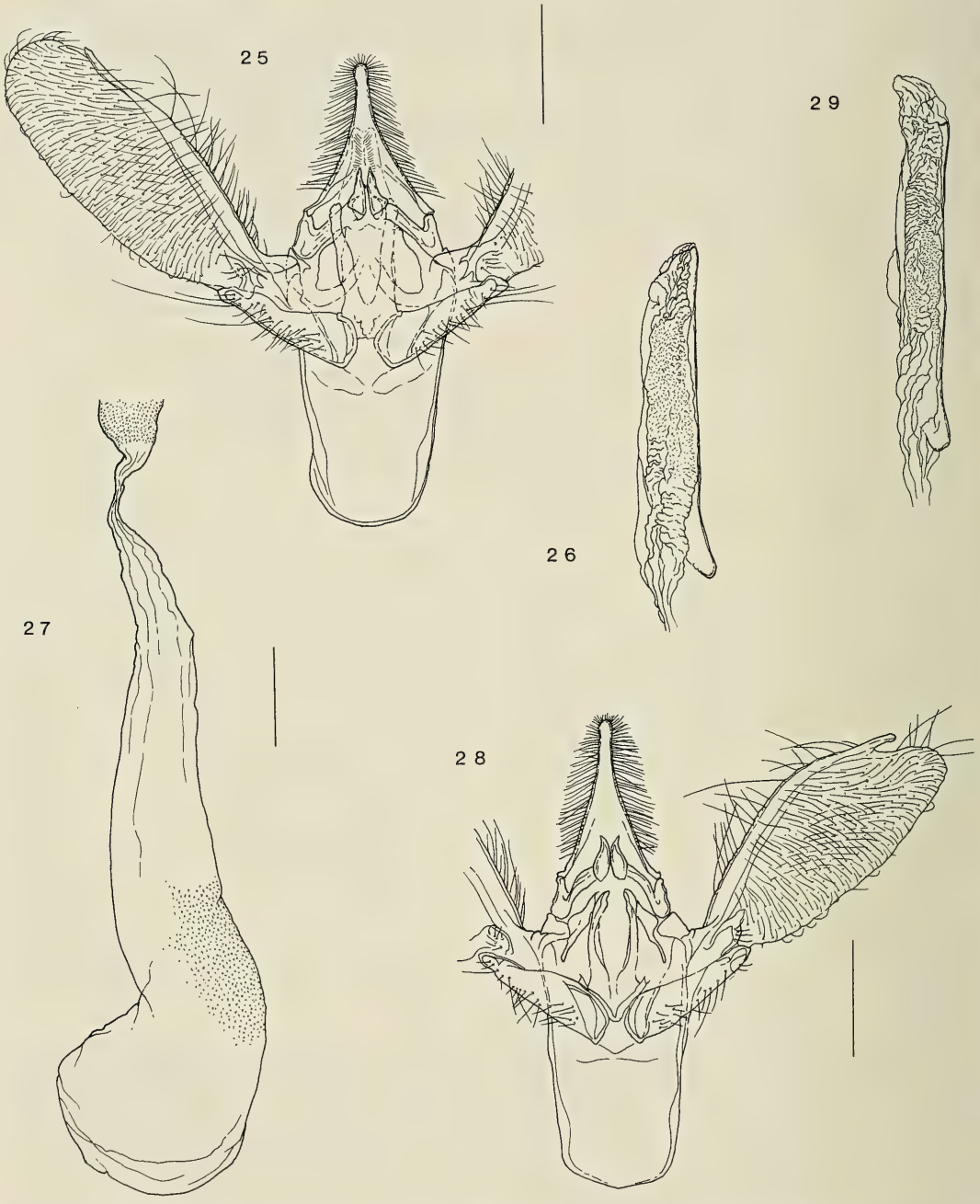
Type locality.—La Vega, 23 km SE Constanza (18-45N, 70-37W), 2225 m, Dominican Republic.

Diagnosis.—*Aptunga vega* is larger than *Aptunga macropasa* and *Aptunga setadebilia. A. vega* also has distinct antemedial and postmedial lines on the forewing; all other known *Aptunga* have indistinct to only moderately well developed transverse lines. Also, unlike other *Aptunga,* where both sexes are known, the labial palpus in *A. vega* is distinctly longer in the female than in the male.

Description.—Length of forewing 11.5–13.0 mm. Head with frons with anteriorly projecting white-tipped reddish brown scales. Vertex similar in color to frons but whiter, particularly near base of antenna; male and female antenna simple; labial palpus (Fig. 24) oblique, rather long, extending well beyond head in male, longer, reaching well above vertex in female, basal segment mostly white with some whitish brown or fuscous, 2nd and 3rd segments reddish brown and fuscous with white distally; maxillary palpus mostly reddish brown, simple in both sexes. Thorax collar fuscous, usually heavily washed with brownish red with a few white scales mesially, dorsum of thorax similar to collar but less brownish red. Forewing with ground color fuscous; antemedial line distinct, broad, white; postmedial line distinct, white; basal area with small, short, longitudinal streaks or patches of red, and a few white scales; subbasal area with scattered red, brownish red and white scales; medial area dusted with white, with few to many scattered, or patches of, red to brownish red scales; discal spots usually distinct, black, fused; terminal area similar to medial area, but with fewer white scales; underside of wing of male without costal fold and sex-scaling. Hindwing pale fuscous, darker along veins and at wing margins. Male abdominal segment 8 with pair of strongly developed, ventrolateral scale tufts. Male genitalia (Figs. 25, 26) with uncus subtriangular, tapering abruptly, apical half narrow, bluntly pointed; gnathos with apical part divided into two tapered elements; transtilla incomplete, consisting of pair of subtriangular plates; juxta with elongate lateral arms that extend to base of apical elements of gnathos; valva relatively simple, with strongly sclerotized costal band for about 6/7 its length; apex of costal band pointed and projecting slightly free of valva; vinculum slightly longer than greatest width; aedoeagus simple. Female genitalia (Fig. 27) with ductus bursae membranous, long with broad band of scobinations near ostium bursae, and patch of scobinations near junction with corpus bursae; corpus bursae membranous, short, without signum; ductus seminalis attached near middle of corpus bursae.

Material examined.—♂ (holotype), La Vega, 23 km SE Constanza (18-45N, 70-37W), 2225 m, grassland with pines and scattered marshes, 24–25 November 1992, D. K. T. R., genitalia slide 3634 HHN; 2 ♀, (paratypes), same collection data, genitalia slide 3636 HHN; 1 ♂, 1 ♀ (paratypes), La Vega 24 km SE Constanza (18-44N, 70-36W), 2220 m, grassland, 16 August 1990, R. T., genitalia slide 3635 HHN.

Discussion.—*Aptunga vega* appears to be associated with high elevation sites



Figs. 25–29. Male and female genitalia. 25, *Aptunga vega,* aedoeagus omitted. 26, *A. vega,* aedoeagus. 27, *A. vega,* ductus bursae and corpus bursae. 28, *A. culmenicola,* aedoeagus omitted. 29, *A. culmenicola,* aedoeagus. (All scale lengths 0.5 mm.)

where grasses are the dominant plant species.

Etymology.—The specific epithet is derived from the type locality (La Vega).

Aptunga culmenicola Neunzig, new species

(Figs. 4, 22, 28, 29)

Type locality.—La Independencia, 15 km NE Los Arroyos (Pedernales); summit of Sierra de Baoruco, 2260 m, Dominican Republic.

Diagnosis.—Similar in size and general appearance to *Aptunga vega,* but the forewing is without the strongly contrasting transverse lines, and is generally darker. The labial palpus of the male is short (Fig. 22) compared to the palpi of other male *Aptunga.*

Description.—Length of forewing 12.5 mm. Head with frons with anteriorly projecting white-tipped fuscous and reddish brown scales. Vertex similar in color to frons but whiter, particularly near base of antenna; male and female antenna simple; labial palpus of male (Fig. 22) oblique, all segments fuscous suffused with black with a few white scales; maxillary palpus mostly fuscous suffused with black, simple in male. Thorax collar fuscous washed with brownish red, dorsum of thorax similar to collar but less brownish red. Forewing with ground color fuscous; antemedial and postmedial lines only moderately well developed, white, not distinctly contrasting with ground color; basal area with short, longitudinal streaks of red, and with a few white scales; subbasal, medial and terminal areas with a few scattered white scales and some red scales, and partially suffused with black; discal spots obscure, fused; underside of wing without costal fold and sex-scaling. Hindwing pale fuscous, darker along veins and near wing margins. Male abdominal segment 8 with pair of well developed, ventrolateral scale tufts. Male genitalia (Figs. 28, 29) with uncus subtriangular, tapering abruptly, apical half narrow, bluntly pointed; gnathos with apical part divided into two tapered elements whose apices diverge; transtilla incomplete, consisting of pair of subtriangular plates; juxta with elongate lateral arms that do not reach base of apical elements of gnathos; valva relatively simple, with strongly sclerotized costal band for about 6/7 its length; apex of costal band rounded and projecting free of valva; vinculum slightly longer than greatest width; aedoeagus simple. Female unknown.

Material examined.—♂ (holotype), La Independencia, 15 km NE Los Arroyos (Pedernales), summit of Sierra de Baoruco, 2260 m, 19 July 1987, D. R., genitalia slide 3776 HHN.

Etymology.—The montane habitat of this species has suggested the name *culmenicola.*

Moodna antilleana Neunzig, new species

(Figs. 5, 30, 31, 37)

Type locality.—Dajabon Province, 13 km S Loma de Cabrera, ca. 400 m, Dominican Republic.

Diagnosis.—In the male of *M. antilleana* the tuft of sex scales associated with the costal fold of the forewing is entirely whitish ochre. This tuft is red or reddish brown distally in other male *Moodna,* such as the similar appearing *Moodna pallidostrinella* Neunzig.

Description.—Length of forewing 7.0–8.0 mm. Head with frons and vertex brownish white to brown; labial palpus outwardly with basal segment mostly white with pale brown or brown, distal segments pale brown or brown usually with a few white scales. Thorax with collar brown, or pale brown, washed with red; dorsum of thorax similar to collar, but usually with less red and sometimes some scales tipped with white. Forewing with base brownish red or red, or combination of mostly brownish red or red and some brown, to antemedial line; antemedial line moderately distinct, consisting of white and white-tipped fuscous scales; medial area brown, strongly dusted with white on costal half and with patch of

red on inner half that sometimes extends onto costal half; discal spots weakly, to well, developed, black, fused; postmedial line same color and as distinct as antemedial line; terminal area brown washed with red and white, sometimes mostly red. Forewing of male with sex-scales of costal fold whitish ochre. Hindwing pale fuscous. Male abdominal segment 8 with dorsal scale tufts. Male genitalia (Figs. 30, 31) with uncus truncate; apical process of gnathos a very slender hook; transtilla incomplete; juxta narrow and semi-oval; valva with two costal projections separated by distance equal to length of inner projection; inner projection sinuate with apical part slightly curved mesially; aedoeagus simple; vinculum longer than greatest width. Female genitalia (Fig. 37) with ductus bursae 2 times as long as corpus bursae, lightly sclerotized for about one-fifth its length posteriorly and with band of very small spines near ostium bursae; corpus bursae membranous, with signum consisting of two small fused discs; ductus seminalis from corpus bursae near signum.

Material examined.—♂ (holotype), Dajabon Province, 13 km S Loma de Cabrera, ca. 400 m, 20–22 May 1973, D. & D., genitalia slide 3858 HHN; 3 ♀ (paratypes), La Vega Province, Constanza, 1164 m, Hotel Nueva Suiza, 29 May 1973, D. & D.; 2 ♀ (paratypes), Pedernales, 37 km N Cabo Rojo (18-09N, 71-35W), 1480 m, 21–22 July 1990, Y. R. T., genitalia slide 3737 HHN.

Discussion.—*Moodna antilleana* appears to be closely related to *Moodna pallidostrinella* Neunzig, but differs as follows: 1. the ochre found on the head, thorax and upper surface of the forewing of *M. pallidostrinella* is absent on *M. antilleana*; 2. the sex-scales associated with the costal fold of the undersurface of the forewing are entirely whitish ochre in *M. antilleana,* but partially brownish red in *M. pallidostrinella*; 3. the inner costal projection of the valva of the male of *M. antilleana* has the apical part curved mesially, and both costal projections close to the base of the valva (Fig. 30), whereas in *M. pallidostrinella* the inner projection is curved outwardly and the projections are more remote from the valva base; 4. the signum of the corpus bursae of the female of *M. antilleana* consists of only two discs (Fig. 37), the signum consists of four fused discs in *M. pallidostrinella.*

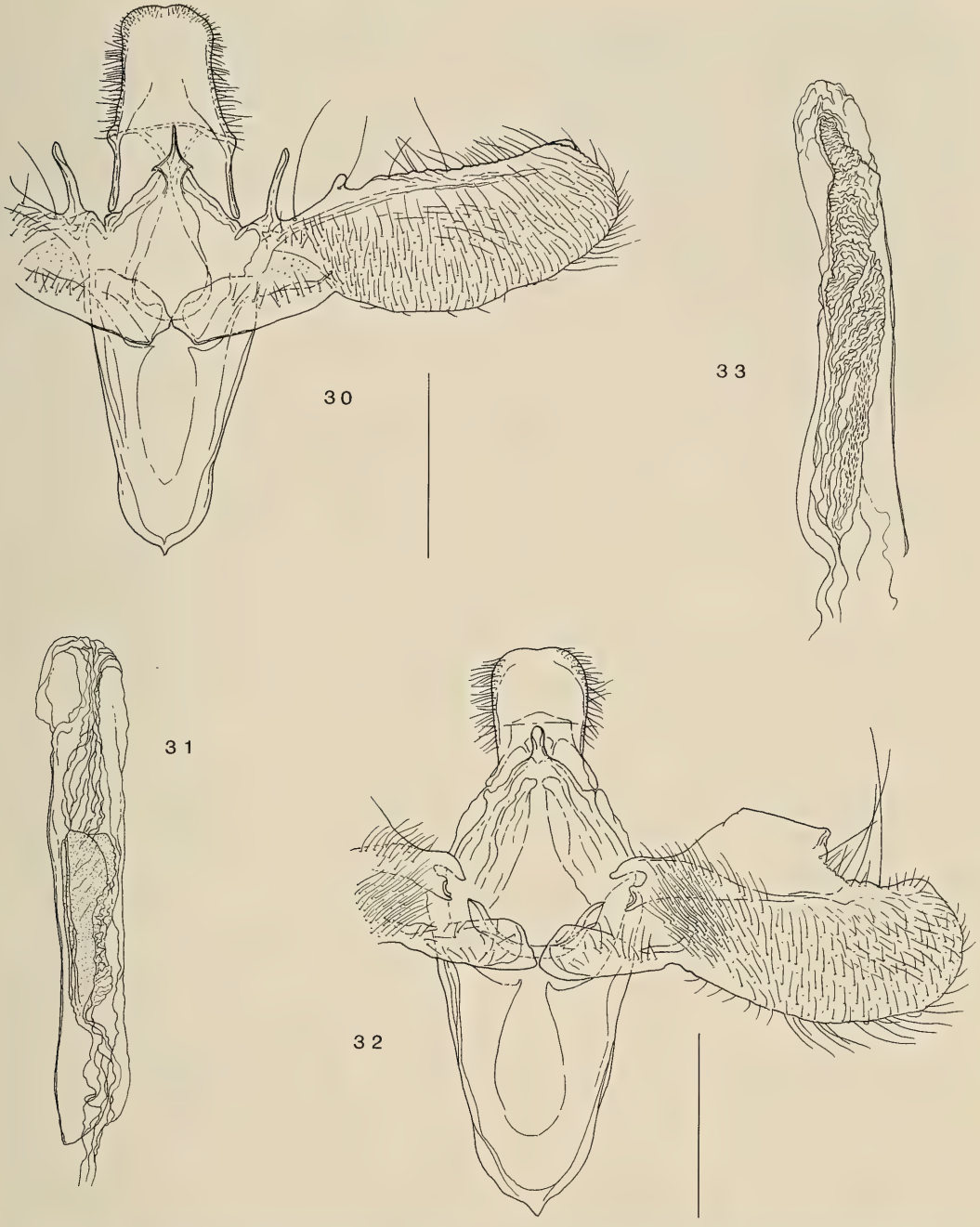
Etymology.—The specific epithet is derived from the type locality (The Antilles) and the Latin suffix *-ana* (belonging to).

Caudellia pilosa Neunzig, new species
(Figs. 6, 32, 33)

Type locality.—La Vega Province, Hotel Montana, ca. 520 m, 10 km NE Jarabacoa, Dominican Republic.

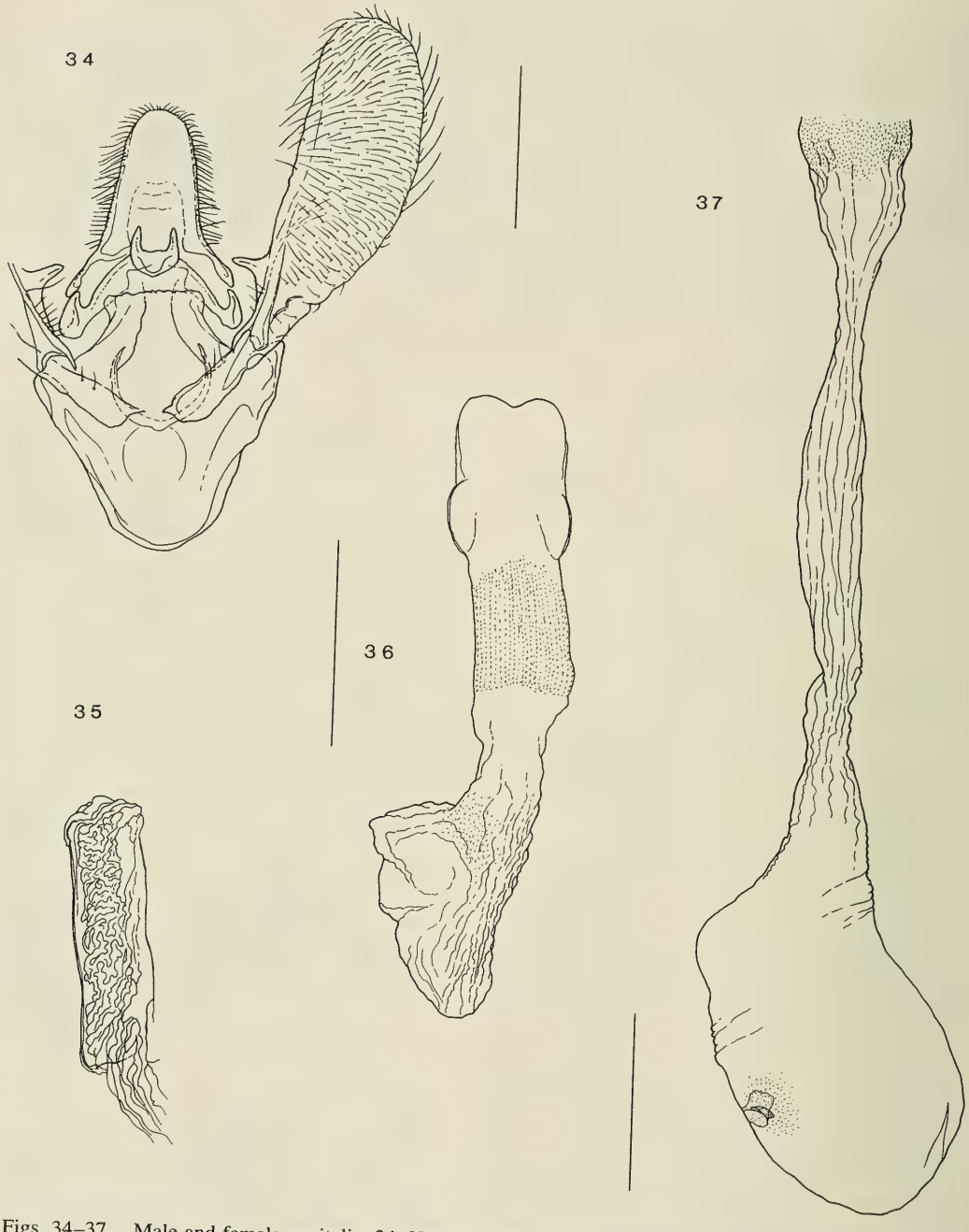
Diagnosis.—The unusually dense patch of setae at the inner base of the male valva readily identifies *Caudellia pilosa.* Based on the male genitalia, *pilosa* appears to be most closely related to *Caudellia clara* Heinrich. *C. clara* most noticeably differs from the new species in having a longer distal element on the gnathos, and a pointed, somewhat detached projection on the costa of the valva (projection truncate and broadly fused to costa in *pilosa*), in addition to lacking a very dense basal patch of setae on the valva.

Description.—Length of forewing 6.5–7.0 mm. Head with frons and vertex brownish gray to fuscous with light dusting of white near eyes; labial palpus brownish gray and black, dusted with white on basal segment and sometimes with white on more distal segments. Thorax with collar brownish gray and black faintly washed with pale reddish brown; dorsum of thorax brownish gray faintly washed with pale reddish brown. Forewing with ground color brownish gray; basal and subbasal area with white and a few reddish brown scales on costal 1/2, with patch of pale purplish brown on inner margin and with suffusion of black medially; antemedial line distinct, white, angled, narrow on inner margin; medial area suffused with black and pale purplish brown, and patch of white at costa distally



Figs. 30–33. Male genitalia. 30, *Moodna antilleana,* aedoeagus omitted. 31, *M. antilleana,* aedoeagus. 32, *Caudellia pilosa,* aedoeagus omitted. 33, *C. pilosa,* aedoeagus. (All scale lengths 0.5 mm.)

and surrounding discal spots; discal spots black, distinct; postmedial line white, weakly developed; underside of wing with red sex-scales associated with costal fold. Hindwing smoky brown. Male abdominal segment 8 with dorsal scale tufts. Male genitalia (Figs. 32, 33) with uncus slightly broader distally than basally; gnathos with



Figs. 34–37. Male and female genitalia. 34, *Varneria albiornatella,* aedoeagus omitted. 35, *V. albiomatella,* aedoeagus. 36, *Varneria albiornatella,* ductus bursae and corpus bursae. 37, *Moodna antilleana,* ductus bursae and corpus bursae. (All scale lengths 0.5 mm.)

central projection short, thumblike; transtilla incomplete with broad lateral arms; juxta shallowly U-shaped; valva with large, truncate costal projection, and with dense patch of setae at inner base; vinculum longer than greatest width; aedoeagus with linear cluster of small spines. Female unknown.

Material examined.—♂ (holotype), La

Vega Province, Hotel Montana, ca. 520 m, 10 km NE Jarabacoa, 28 May 1973, D. & D., genitalia slide 3871 HHN; 1 ♂ (paratype), same collection data.

Etymology.—The specific epithet is derived from the Latin *pilosus* in reference to the dense patch of setae at the base of the male valva.

Varneria albiornatella Neunzig, new species
(Figs. 7, 34–36)

Type locality.—Peravia, 3 km SW La Nuez, tributary to Rio Las Cuevas (18-40N, 70-36W), 1870 m, Dominican Republic.

Diagnosis.—*Varneria albiornatella* differs from other nominal species of *Varneria* in having large patches of white on the forewing; all other *Varneria* lack pale scales on the forewing (*V. postremella* Dyar, *V. nannodes* Dyar), or have weakly developed white or near-white antemedial and postmedial lines (*V. atrifasciella* Barnes and McDunnough, *V. dubia* Heinrich).

Description.—Length of forewing 6.0–8.5 mm. Head with frons with pale brown to fuscous scales; vertex pale brown; male and female antenna simple; labial palpus oblique to upcurved, basal segment white, or mostly white, 2nd segment mostly fuscous with a few white distal scales, 3rd segment fuscous; maxillary palpus simple, pale brown. Thorax collar and dorsum pale brown to fuscous washed with pale reddish brown or purple. Forewing with costal half mostly white and posterior half with dominant color brownish red, red, or purplish red; some scattered brownish red, red or purplish red scales on costal half; antemedial line rather well developed, white, strongly angled from costa to posterior margin of wing; postmedial line moderately well developed, white; black patches at base of wing, along costa, in posterior part of subbasal area, bordering distal margin of antemedial line, bordering proximal part of postmedial line, and in distal area; discal spots obscure to moderately distinct, black, fused; underside of wing of male with costal fold. Hindwing pale fuscous, darker along veins and at margins. Male genitalia (Figs. 34, 35) with uncus subtriangular, broadly rounded apically; gnathos with distal part U-shaped, prongs short and straight; transtilla complete, truncate with broad lateral bases; juxta a shield with narrow lateral arms; valva with projecting dorsal spur near base of costa; spur slightly curved toward base of valva; vinculum distinctly shorter than greatest width; aedoeagus somewhat short, straight, unarmed. Female genitalia (Fig. 36) with ductus bursae sclerotized and flattened posteriorly for slightly over one-half its length; anterior part of this sclerotized area also scobinate; dorsal shield behind ostium bursae concave along posterior margin; corpus bursae short small, without signum; ductus seminalis from near middle of corpus bursae.

Material examined.—♂ (holotype), Peravia, 3 km SW La Nuez, tributary to Rio Las Cuevas (18-40N, 70-36W), 1870 m, 5–6 August 1990, R. T., genitalia slide 3767 HHN; 1 ♂, 1 ♀ (paratypes), Pedernales, 5 km NE Los Arroyos (18-15N, 71-45W), 1680 m, 17–18 July 1990, Y. R. S., genitalia slides 3639 HHN, 3640 HHN.

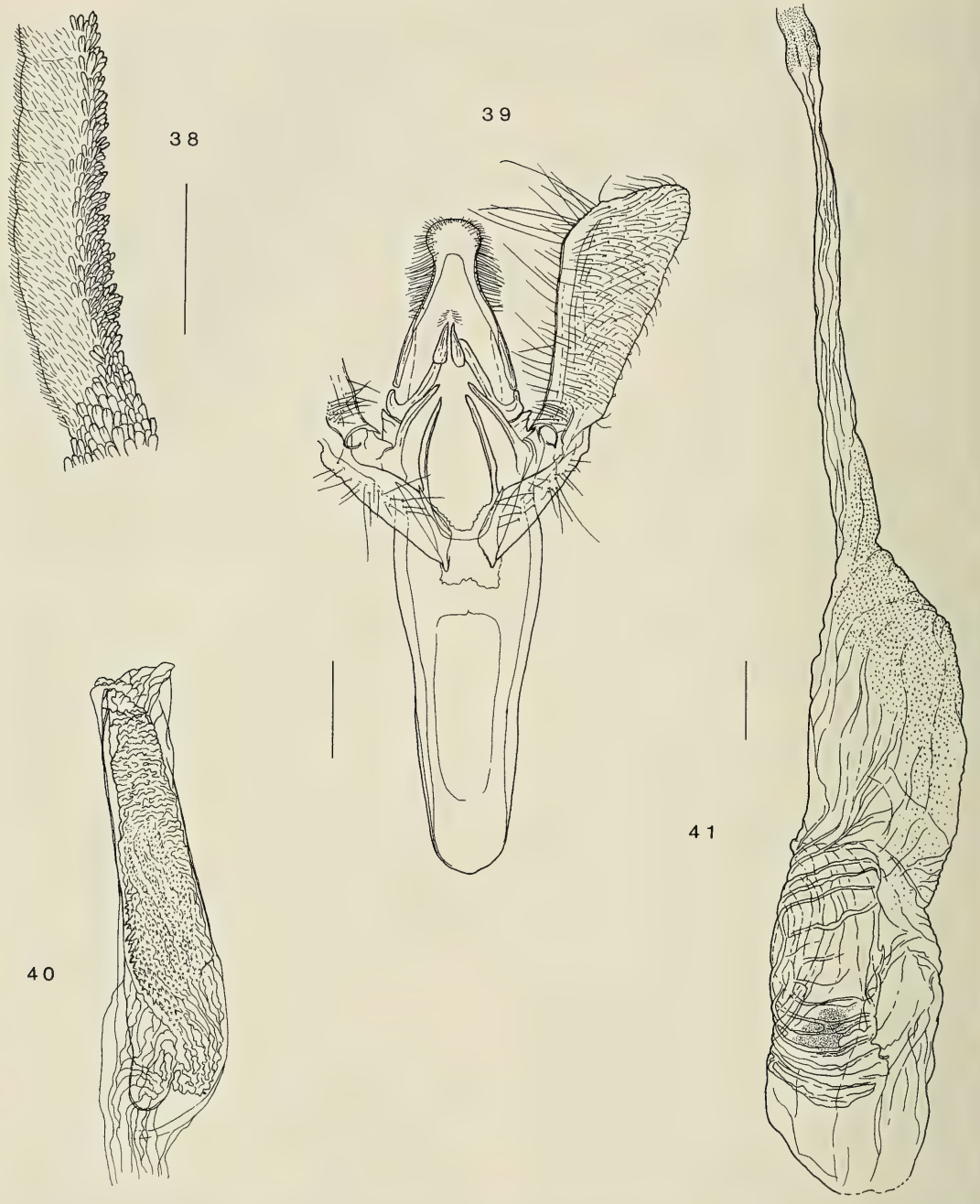
Etymology.—The presence of white patches on the forewing has suggested the name *albiornatella* for this species.

Ozamia plagata Neunzig, new species
(Figs. 8, 38–41)

Type locality.—Pedernales, 14.5 km N Cabo Rojo (18-03N, 71-39W), 165 m, Dominican Republic.

Diagnosis.—The contrasting light and dark longitudinal lines or streaks on the forewing (Fig. 8) in conjunction with the clusters of scalelike sensilla at the base of the male antenna (Fig. 38) make this species easy to identify. Other *Ozamia,* such as *O. lucidalis* (Walker) that is also found in the Dominican Republic, have the antennal sensilla, but lack longitudinal lines on the forewing.

Description.—Length of forewing 9.5–



Figs. 38–41. Male antenna and male and female genitalia of *Ozamia plagata*. 38, Base of antenna. 39, Male genitalia, aedoeagus omitted. 40, Aedoeagus. 41, Ductus bursae and corpus bursae. (All scale lengths 0.5 mm.)

12.5 mm. Head pale brown to brown; vertex with white at base of antenna and extending above eyes; male antenna (Fig. 38) with six to seven clusters of scalelike sensilla within basal sinus; labial palpus oblique, pale brown to brown dusted with white; maxillary palpus simple, pale brown to brown dusted with white. Thorax with

collar pale brown to fuscous lightly dusted with white and with pure white mesially; dorsum of thorax pale brown to fuscous lightly dusted with white. Forewing with ground color pale brown to brown with fuscous to black longitudinal streaks on veins or paralleling veins and longitudinal streaks of white between dark streaks (some specimens with broader suffusions or patches of fuscous or black); antemedial and postmedial lines usually absent (a few darker specimens with vague, white antemedial line); discal spots indistinct. Hindwing semi-hyaline, dark near costal and outer margins. Male genitalia (Figs. 39, 40) with distal part of uncus broad; gnathos with apical process rather small, bifid; transtilla incomplete mesially; juxta with long slender lateral arms; valva simple with apex oblique; vinculum slender, over 2× as long as greatest width; aedoeagus moderately stout and scobinate. Female genitalia (Fig. 41) with ductus bursae, elongate, membranous, minutely scobinate near genital opening and with larger microspines near junction with corpus bursae; corpus bursae membranous, with microspines posteriorly, without distinct signum but with slightly sclerotized region and distinct wrinkles in anterior half; ductus seminalis from near middle of corpus bursae.

Material examined.—♂ (holotype), Pedernales, 14.5 km N Cabo Rojo (18-03N, 71-39W), 165 m, 13 July 1990, R. Y. T., genitalia slide 3648 HHN; 1 ♂ (paratype), Monte Cristi Prov., 10 km S Monte Cristi, 5 m, 23 May 1973 D. & D.; 2 ♂, 6 ♀ (paratypes), Pedernales, 8 km N Cabo Rojo, 30 m, 18 July 1987, D. R.; 2 ♂ (paratypes), Pedernales, 14.5 km N. Cabo Rojo (18-03N, 71-39W), 165 m, 13 July 1990, R. Y. T.; 4 ♂, 3 ♀ (paratypes), Pedernales, 14.5 km N Cabo Rojo (18-03N, 71-39W), 165 m, 19 July 1990, R. Y. T.; 1 ♂, 3 ♀ (paratypes), Pedernales, 1 km W. Cabo Rojo (17-55N, 71-39W), 10 m, 30 July 1990, Y. R. T.; 3 ♂, 3 ♀ (paratypes), Pedernales, 14.5 km N Cabo Rojo (18-03N, 71-39W), arid thornscrub, 165 m, 26–27 September 1991 Y. T. D. R., genitalia slides 3649 HHN, 3650 HHN; 2 ♂ (paratypes), Pedernales, Cabo Rojo (17-55N, 71-39W), coastal desert, 10 m, 26–27 September 1991, Y. T. D. R.; 1 ♂, 1 ♀ (paratypes), La Altagracia 2 km N Bayahibe (18-23N, 68-51W), dry seasonal forest on limestone, 10 m, 3 July 1992, Y. D. T. R.; 1 ♂ (paratype), Independencia, 4 km S Los Pinos, Loma de Vientos (18-35N, 77-46W), semiarid deciduous forest with pastures, 455 m, 23 July 1992, D. R. T. Y.; 3 ♂, 5 ♀ (paratypes), Monte Cristi, 5 km NNE Botocillo (19-46N, 71-24W), arid thornscrub, 50 m, 29–30 November, 1992, D. K. T. R., genitalia slides 3651 HHN, 3652 HHN.

Discussion.—Larvae of *Ozamia* are known to feed on several species of cactus, particularly those in the genus *Opuntia* Miller. *Opuntia* occurs in the Dominican Republic (Moscoso 1943) and is probably the larval host of *Ozamia plagata.* Label information on adult specimens lend credence to this proposed cactus association in that adult specimens were collected in "coastal desert," "dry seasonal forest," "semiarid deciduous forest," and "thornscrub."

Etymology.—The presence of contrastingly colored streaks on the forewing has suggested the name *plagata* for this species.

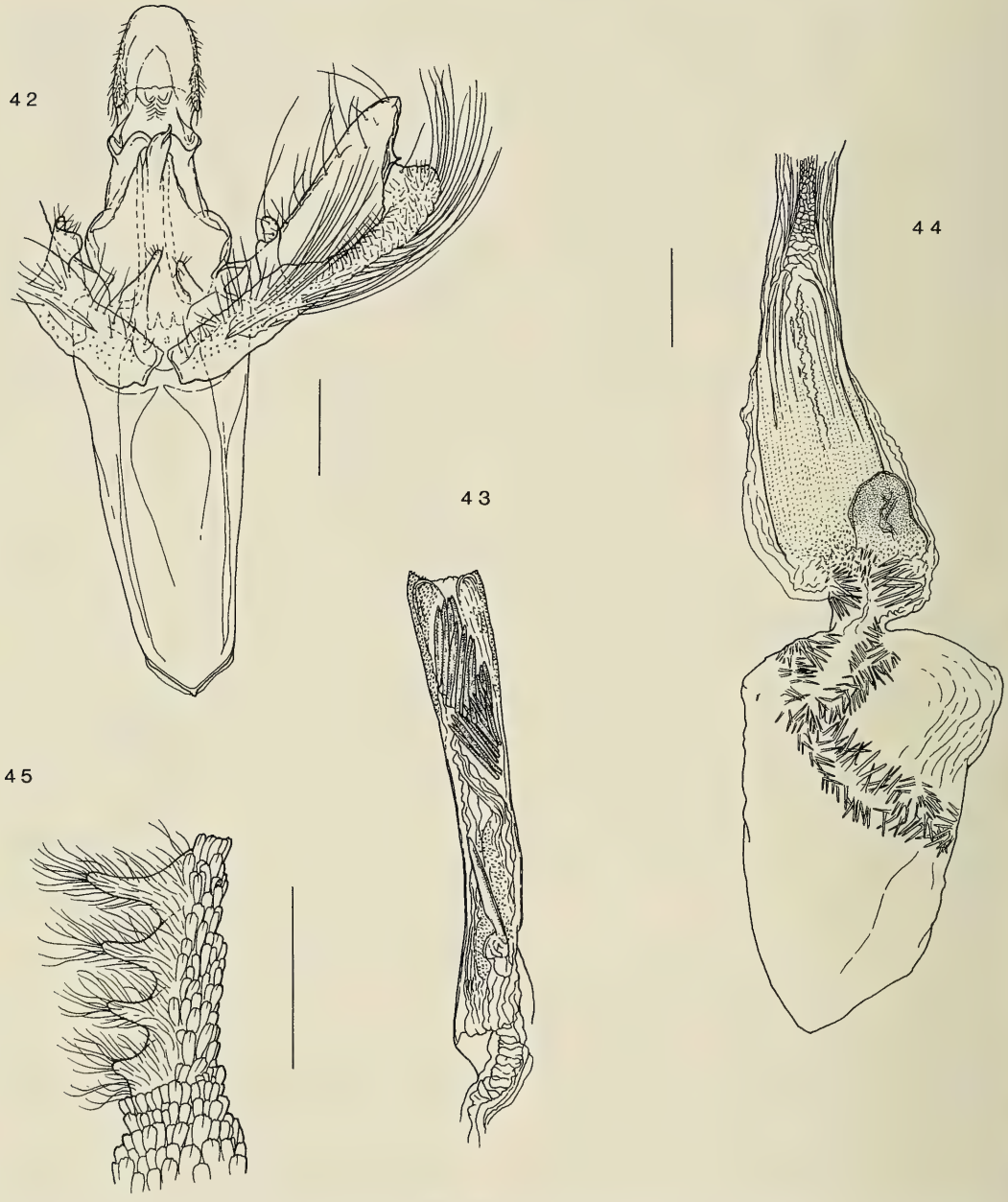
Dioryctria postmajorella Neunzig, new species

(Figs. 9, 42–45)

Type locality.—Independencia, 3 km ESE El Aguacate, north slope Sierra de Baoruco (18-18N, 71-42W), 1980 m, Dominican Republic.

Diagnosis.—The female genitalia of *D. postmajorella* can be used to identify the species. A rather large, sclerotized, thickened, spinefree, platelike element is associated with the cluster of spines in the anterior of the ductus bursae; this feature is absent in other *Dioryctria,* including the closely related *D. majorella* Dyar.

Description.—Length of forewing 12.0–15.0 mm. Head with frons white and fuscous or black, many dark scales directed



Figs. 42–45. Male antenna and male and female genitalia of *Dioryctria postmajorella*. 42, Male genitalia, aedoeagus omitted. 43, Aedoeagus. 44, Ductus bursae and corpus bursae. 45, Base of antenna. (All scale lengths 0.5 mm.)

anteriorly and tipped with white; vertex similar to frons but more heavily dusted with white; male antenna (Fig. 45) strongly serrate (almost unipectinate), with several, partially exposed, black spinelike sensilla along base of shaft; female antenna simple; labial palpus oblique in both sexes (held close to frons in male), fuscous or black dusted with white; maxillary palpus simple, very short in male, white and fuscous. Tho-

rax with collar and dorsum gray usually lightly washed with reddish brown anteriorly and with a few black scales. Forewing for the most part smooth, with a few indistinct patches of slightly raised scales; ground color gray; black subbasal patch (of very slightly raised scales) followed by faint reddish brown or purplish brown patch preceding antemedial line; antemedial line moderately distinct, consisting of white-tipped gray scales, edged with black distally and followed by patch of white-tipped scales; small group of black scales and larger faint, reddish brown to purplish brown patch distad of patch of white-tipped scales; discal spots covered with white and with associated black patch; postmedial line moderately distinct formed of white-tipped gray scales, preceded by thin black line and bordered on distal margin by mixture of black and faint reddish brown or purplish brown scales; underside of wing of male without costal fold and without sex-scaling. Hindwing pale fuscous, darker along veins and wing margins. Male abdominal segment 8 with ventral scale tufts. Male genitalia (Figs. 42, 43) with uncus constricted at base and with distinct lateral protuberances; apical process of gnathos simple, hooklike; transtilla incomplete; juxta with slender setiferous lateral lobes; valva rather broad, with distal posterior part triangular and with small tooth on margin; subbasal lobe well developed, cupped; aedoeagus armed with many, medium-sized, clustered cornuti and one large cornutus; vinculum about 2× as long as greatest width. Female genitalia (Fig. 44) with ductus bursae flattened, mostly sclerotized and longitudinally ridged with proximal part distinctly narrower than distal part, and with cluster of spines and rather large, spine-free sclerotized, thickened platelike element distally; corpus bursae membranous, about as long as ductus bursae, with signum a sinuous loop of small spines; ductus seminalis from corpus bursae near junction with ductus bursae.

Material examined.—♂ (holotype), Independencia, 3 km ESE EI Aguacate, north slope Sierra de Baoruco, pine woodland (18-18N, 71-42W), 1980 m, 28–29 September 1991, R. D. Y. T., genitalia slide 3674 HHN; 1 ♀ (paratype), La Vega Province, Constanza, 116 m, Hotel Nueva Suiza, 29 May 1973, D. & D., genitalia slide 3857 HHN; 3 ♂ (paratypes), Pedernales, 9.7 km NE Los Arroyos (18-16N, 71-44W), 2070 m, 15–16 July 1990, R. Y. T., genitalia slide 3676 HHN; 1 ♂, 2 ♀ (paratypes), Pedernales, 37 km N Cabo Rojo (18-09N, 71-35W), 1480 m, 21–22 July 1990, Y. R. T.; 3 ♀ (paratypes), Pedernales, 30 km N Cabo Rojo (18-07N,71-39W), Y. R. T. genitalia slide 3677 HHN; 1 ♀ (paratype), Pedernales, 26 km N Cabo Rojo (18-06N, 71-38W), 730 m, 31 July 1990, R. Y. T.; 3 ♂, 4 ♀; (paratypes), Independencia, 3 km ESE EI Aguacate, north slope Sierra de Baoruco, 1980 m (18-18N, 71-42W), 28–29 September 1991, R. D. Y. T., genitalia slide 3675 HHN.

Discussion.—Males of *Dioryctria postmajorella* have unusual, strongly serrate, almost pectinate, antennae previously known only as occurring on *Dioryctria majorella.* The lateral lobes of the serrate antennae appear to be slightly longer in *D. postmajorella* than in *D. majorella.*

All members of the genus *Dioryctria* feed as larvae on conifers. It is likely that *Pinus occidentalis* Swartz, endemic to the Dominican Republic (Moscoso 1943), is the larval host of *D. postmajorella.*

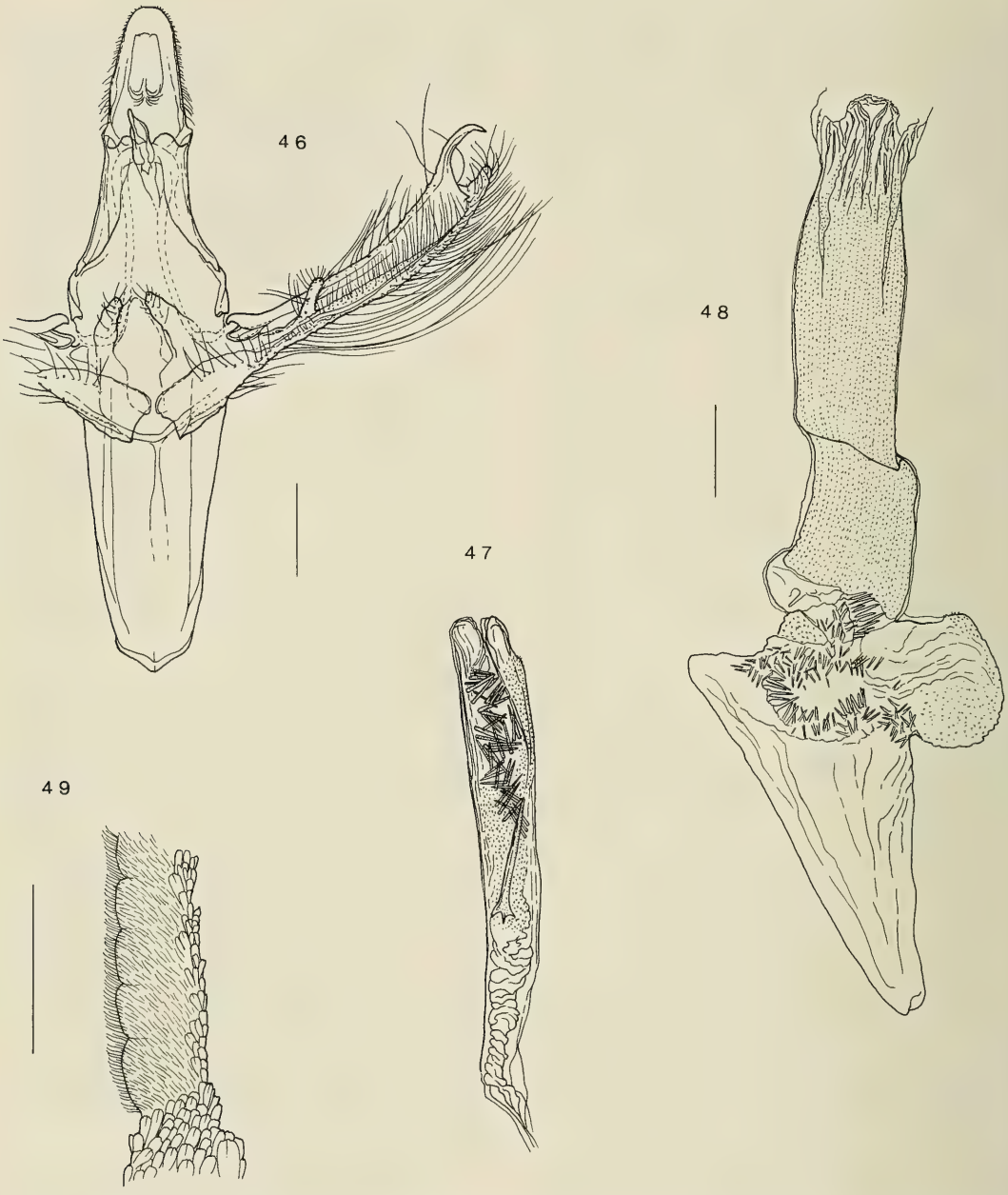
Etymology.—The specific epithet *postmajorella* denotes the close similarity of this species to *D. majorella.*

Dioryctria dominguensis Neunzig, new species

(Figs. 10, 46–49)

Type locality.—Independencia, 3 km ESE EI Aguacate, north slope Sierra de Baoruco, (18-18N, 71-42W), 1980 m, Dominican Republic.

Diagnosis.—*Dioryctria dominguensis* is similar to *Dioryctria merkeli* Mutuura and Munroe, but the markings on the forewing are generally more distinct in *D. domin-*



Figs. 46–49. Male antenna and male and female genitalia of *Dioryctria dominguensis*. 46, Male genitalia, aedoeagus omitted. 47, Aedoeagus. 48, Ductus bursae and corpus bursae. 49, Base of antenna. (All scale lengths 0.5 mm.)

guensis. Also, the postmedial line in *D. dominguensis* is distinctively broadened near the costa.

Description.—Length of forewing 13.5–16.0 mm. Head with frons and vertex fuscous dusted with white and washed with reddish brown, white at base of antenna. Male antenna (Fig. 49) with shaft very slightly serrate and with several very short, black thickened, partially exposed, spine-

like sensilla near base. Female antenna simple. Labial palpus oblique in both sexes (held close to frons in male), fuscous, dusted with varying amounts of white and, in some specimens, with a few to moderate numbers of reddish brown scales; maxillary palpus simple, fuscous and white. Thorax collar fuscous and reddish brown, in some specimens dusted with white; dorsum of thorax similar to collar, but usually somewhat darker. Forewing with small basal and subbasal ridge, a patch of raised scales in median area near antemedial line, and weakly raised scales at discal spot and near postmedial line; ground color fuscous; antemedial and postmedial lines white, lightly suffused with reddish brown and fuscous, distinct, edged proximally and distally with black; antemedial and postmedial lines noticeably broadened near costa; subbasal area with white preceding subbasal scale ridge; medial area with mostly white patch distad of black line edging antemedial line, and with additional white near costa and preceding black line at margin of postmedial line; narrow band of white preceding terminal line; extensive reddish brown suffusions at base of wing, and distad of subbasal scale ridge, median scale ridge, and beyond black line proximad of postmedial line; underside of wing of male with narrow line of yellowish brown subcostal sexscales. Hindwing pale fuscous, darker along veins and wing margins. Male abdominal segment 8 with ventral scale tufts. Male genitalia (Figs. 46, 47) with uncus not distinctly constricted at base, without obvious lateral protuberances; apical process of gnathos simple, hooklike; juxta with robust setiferous, lateral lobes; valva slender with clawlike distal element and fingerlike subbasal lobe; aedoeagus armed with cluster of many small cornuti and one medium-sized cornutus; vinculum about 2× as long as greatest width. Female genitalia (Fig. 48) with ductus bursae flattened, sclerotized, ridged basally, with basal part about as wide as distal part and with distal cluster of spines; corpus bursae membranous, slightly shorter than ductus bursae, with signum a sinuous loop of small spines; ductus seminalis from corpus bursae near junction with ductus bursae.

Material examined.—♂ (holotype), Independencia, 3 km ESE EI Aguacate, north slope Sierra de Baoruco (18-18N, 71-42W), 1980 m, pine woodland, 28–29 September 1991, Y. T., genitalia slide 3670 HHN; 1 ♂, 2 ♀ (paratypes), La Independencia, 15 km NE Los Arroyos (Pedernales), summit of Sierra de Baoruco, 2260 m, 19 July 1987, D. R.; 1 ♀ (paratype), Pedernales, 9.7 km NE Los Arroyos (18-16N, 71-44W), 2070 m, 15–16 July 1990, R. Y. T.; 4 ♂, 3 ♀ (paratypes), Independencia, 3 km ESE EI Aguacate, north slope Sierra de Baoruco (18-18N, 71-42W), 1980 m, 28–29 September 1991, R. D. Y. T., genitalia slides 3671 HHN, 3672 HHN, 3673 HHN.

Discussion.—As with *Dioryctria postmajorella,* there is a strong possibility that larvae of *D. dominguensis* are associated with *Pinus occidentalis.*

Etymology.—The specific epithet is derived from the type locality (Dominican Republic) and the Latin suffix *-ensis* (denoting place).

Dasypyga independencia Neunzig, new species

(Figs. 11, 50–52)

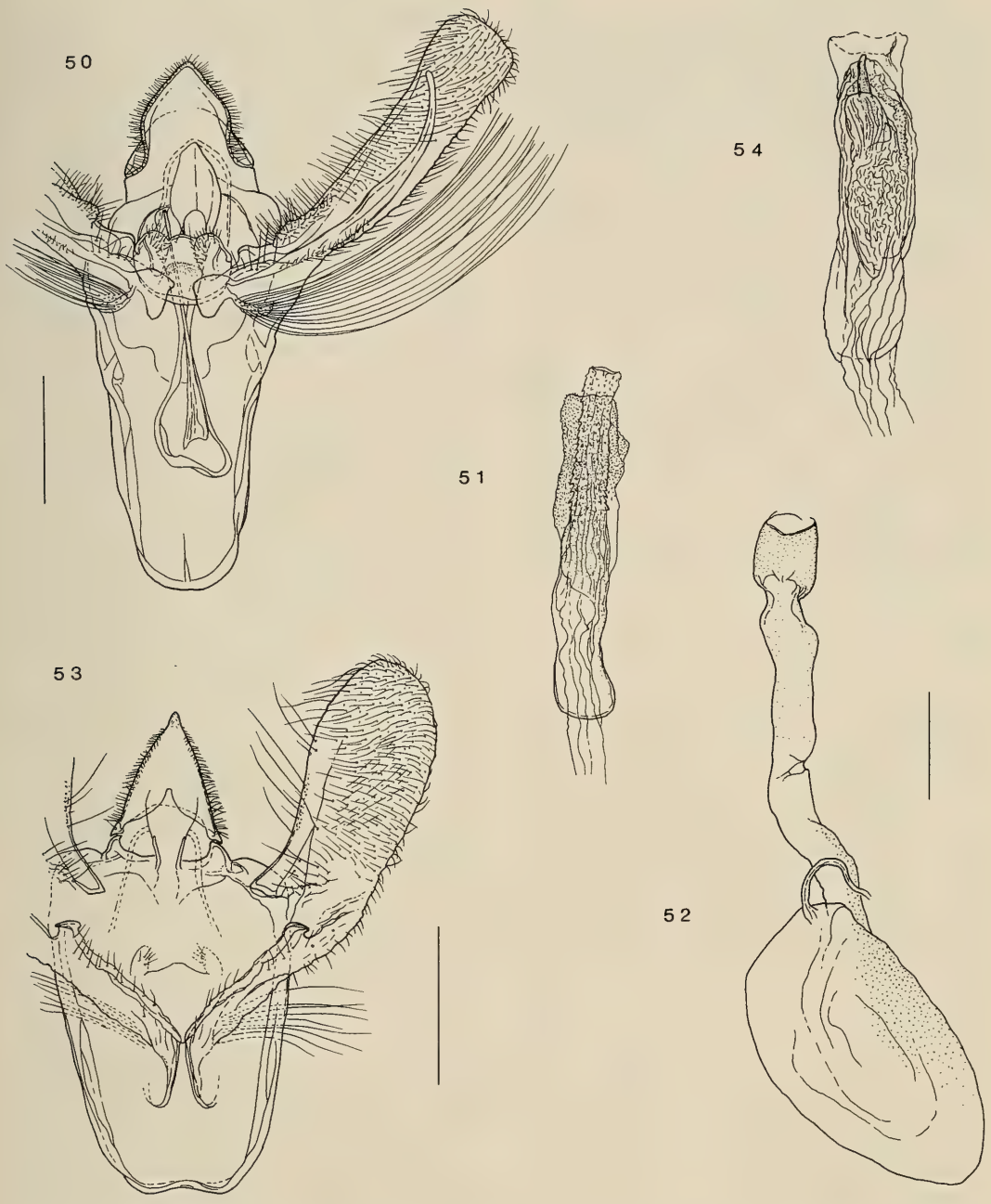
Type locality.—Independencia, 3 km ESE EI Aguacate, north slope Sierra de Baoruco (18-18N, 71-42W), 1980 m, Dominican Republic.

Diagnosis.—The external habitus of *D. independencia* resembles that of *Dasypyga belizensis* Neunzig and Dow. The two species can be most accurately separated by reference to genitalic differences such as the following: males of *D. belizensis* have the spine forming the distal half of the sacculus with a strongly swollen base, and the aedoeagus abruptly enlarged basally on one side, and females of *D. belizensis* have the ductus bursae with obvious sclerotization in the anterior half, whereas males of *D. independencia* have the spine forming the

distal half of the sacculus with only a slightly swollen base, and the aedoeagus is not abruptly enlarged basally on one side, and females of *D. independencia* have the ductus bursae without sclerotization, or with very pale sclerotization, in the anterior half.

Description.—Length of forewing 11.0–12.5 mm. Head with frons rather smoothly scaled, purplish brown washed with reddish brown and ochre; vertex ochre and pale reddish brown to reddish brown; male and female antenna simple; male and female labial palpus upcurved, brownish red with varying amounts of ochre, or red, scales. Male and female maxillary palpus simple, ochre or brownish white. Thorax with collar ochre and brownish red or brownish purple, dorsum of thorax brownish purple and fuscous. Forewing with basal and subbasal area brownish purple lightly dusted with white; posterior half of subbasal area more suffused with purple and with small ridge of white-tipped black scales at wing margin; small basal and subbasal tufts of black, or white-tipped black, scales in median fold; antemedial line indistinct, dark ochre edged distally with dark red, followed by line of black scales (this line of black scales weak or missing near costa and replaced in median fold with black patch of raised scales that extends distally); postmedial line indistinct, ochre and red, deeply angulate between M_2 and M_3, reaching inward to discal spots (this angulation margined proximally with black or dark red and with associated white line); area between transverse lines mostly brownish purple (red, purplish red or red and ochre near costa), in part dusted with white; remainder of median area mostly reddish brown, ochre and pale purple; discal spots brownish purple, obscure, fused; terminal area brownish purple dusted with white; underside of wing of male without costal fold and sex scaling. Hindwing rather dark, brownish gray. Male abdominal segment 8 with sternite developed as narrow sclerotized pocket. Male genitalia (Figs. 50, 51) with apex of uncus trilobate; apical part of gnathos undeveloped; transtilla an asymmetrically lobed, tonguelike structure fused with gnathos; juxta a plate with well-developed, knoblike, setiferous lateral elements; base of juxta with associated U-shaped band supporting a long, sclerotized spine (U-shaped band located in part, or entirely in anterior half of vinculum); valva with distal margin approximately perpendicular (not oblique) to costa of valva; valva with sacculus strongly sclerotized and developed in distal half into a long, slender curved spine (spine with only a slightly swollen base); aedoeagus apically toothed for about 1/2 its length, and with slightly enlarged base; pair of setal tufts from intersegmental area adjacent to outer surface of sacculus at base; vinculum longer than greatest width. Female genitalia (Fig. 52) with collar of eighth abdominal segment with ventral lobes narrow near meson; ductus bursae sclerotized and inflated for about one-fifth its length from ostium bursae; remainder of ductus bursae without sclerotization or with very light sclerotization, and without sclerotized ridges; corpus bursae membranous, in part finely scobinate, without signum; ductus seminalis from corpus bursae near junction of ductus bursae and corpus bursae.

Material examined.—♂ (holotype), Independencia, 3 km ESE El Aguacate, north slope Sierra de Baoruco (18-18N, 71-42W), pine woodland, 1980 m, 28–29 September 1991, R. D. Y. T., genitalia slide 3667 HHN; 6 ♂, 2 ♀ (paratypes), La Vega Province, Constanza, 1164 m, Hotel Nueva Suiza, 29 May 1973, D. & D., genitalia slides 3836 HHN, 3837 HHN; 1 ♂, 1 ♀ (paratypes), Pedernales, 8 km NE Los Arroyos (18-16N, 71-44W), 1940 m, 14 July 1990, R. Y. T., genitalia slide 3778 HHN; 1 ♂ (paratype), Pedernales, 9.7 km NE Los Arroyos (18-16N, 71-44W), 2070 m, 15–16 July 1990, R. Y. T., genitalia slide 3669 HHN; 1 ♀ (paratype), Pedernales, 5 km NE Los Arroyos (18-15N, 71-45W), 1680 m, 17–18 July 1990, Y. R. T.; 1 ♀ (paratype), Pedernales, 37 km N Cabo Rojo (18-09N,



Figs. 50–54. Male and female genitalia. 50, *Dasypyga independencia,* aedoeagus omitted. 51, *D. independencia,* aedoeagus. 52, *D. independencia,* ductus bursae, corpus bursae, and ductus seminalis. 53, *Lascelina pedernalensis,* aedoeagus omitted. 54, *L. pedemalensis,* aedoeagus. (All scale lengths 0.5 mm.)

71-35W), 1480 m, 21–22 July 1990, Y. R. T.; 1 ♀ (paratype), same collection data as holotype, genitalia slide 3668 HHN.

Discussion.—Heinrich (1920, 1956) published on the biology of *Dasypyga alternosquamella* Ragonot, a North American species, and stated that the larvae feed on *Arceuthobium* (*Razamofskya*) *cryptopodum*

Engelmann (Loranthaceae)growing on pine and spruce. The mistletoe *Arceuthobium bicarinatum* Urban occurs in the Dominican Republic (Moscoso 1943), hence the larval food of *D. Independencia* is probably mistletoe.

Etymology.—The specific epithet is based on the type locality (Independencia).

Lascelina pedernalensis Neunzig, new species

(Figs 12, 53, 54)

Type locality.—Pedernales, along Rio Mulito, 13 km N Pedernales (18-09N, 71-46W), 230 m, Dominican Republic.

Diagnosis.—The male genitalia with their reduced gnathos and general habitus place *pedernalensis* in *Lascelina.* The male antenna, particularly the presence of an anteromesial cluster of scales at the sinus and the scalelike sensilla distinguish *pedernalensis* from the only other species in the genus, *L. canens* Heinrich.

Description.—Length of forewing 6.0–6.5 mm. Head with frons pale brown and brownish white suffused with black; vertex similar to frons but with few or no black scales. Male antenna with sinus and strong anteromesial and posterolateral scaletufts at base of shaft, and with group of short, setalike sensilla at base, and at apical end, of sinus; labial palpus white, black, brownish red and/or pale brown; maxillary palpus same as labial palpus. Thorax collar pale brown with a few darker scales anteriorly; dorsum of thorax similar to collar. Forewing mostly white on costal half, shaded with pale brownish or ochre on posterior half; a few scattered brownish red scales, and patch of black scales, at base of wing; antemedial line not particularly evident, blending with general white color of wing, its distal border vaguely delineated by black patch on costal half that is pale brown or ochre on posterior half; median area with thin black costal patch; discal spots black, separate, weakly developed; postmedial line indistinct, margined by discontinuous black lines or patches proximally and distally; underside of wing of male without costal fold and sex-scales. Hindwing pale fuscous, darker along veins and near wing margins. Male genitalia (Figs, 53, 54) with uncus triangular; gnathos with its apical process greatly reduced; transtilla absent; juxta with short, sparsely setiferous, lateral arms; valva rather broad and short, with inner, slightly hooked lobe and basal tuft of slender scales on sacculus; aedoeagus rather short with spined element and scobinations; vinculum about as long as greatest width. Female unknown.

Material examined.—♂ (holotype), Pedernales, along Rio Mulito, 13 km N Pedernales (18-09N, 71-46W), riparian woodland, 230 m, 17 July 1992, R. T. Y. D., genitalia slide 3692 HHN; 1 ♂ (paratype), Pedernales, 9.5 km N Cabo Rojo (18-02N, 71-39W), 35 m, 19 July 1990, R. Y. T., genitalia slide 3979 HHN; 1 ♂ (paratype), Pedernales, 1 km W Cabo Rojo (17-55N, 71-39W), 10 m, 30 July 1990, Y. R. T.

Discussion.—Although the male genitalia of *L. pedernalensis* and *L. canens,* the type species of *Lascelina* Heinrich, are similar, I have some misgivings about placing *pedernalensis* in *Lascelina,* because of obvious differences in the male antennae of the two species. In *L. pedernalensis* the antenna has the segments of the shaft at the sinus distinctly broadened and covered anteromesially with a distinct cluster of scales and two groups of short, setalike sensilla within the sinus, whereas in *L. canens* the antenna does not have the segments of the shaft at the sinus broadened, the anteromesial edge of the sinus is not covered with a cluster of scales, and the sensilla associated with the sinus are robust and spinelike. Nevertheless, because of the appearance of the male genitalia of *L. pedernalensis* and *L. canens,* and inasmuch as no females of *L. pedernalensis* are available for study, it seems, at this time, best to place *L. pedernalensis* in *Lascelina.*

Etymology.—The specific epithet is derived from the type locality (Pedernales)

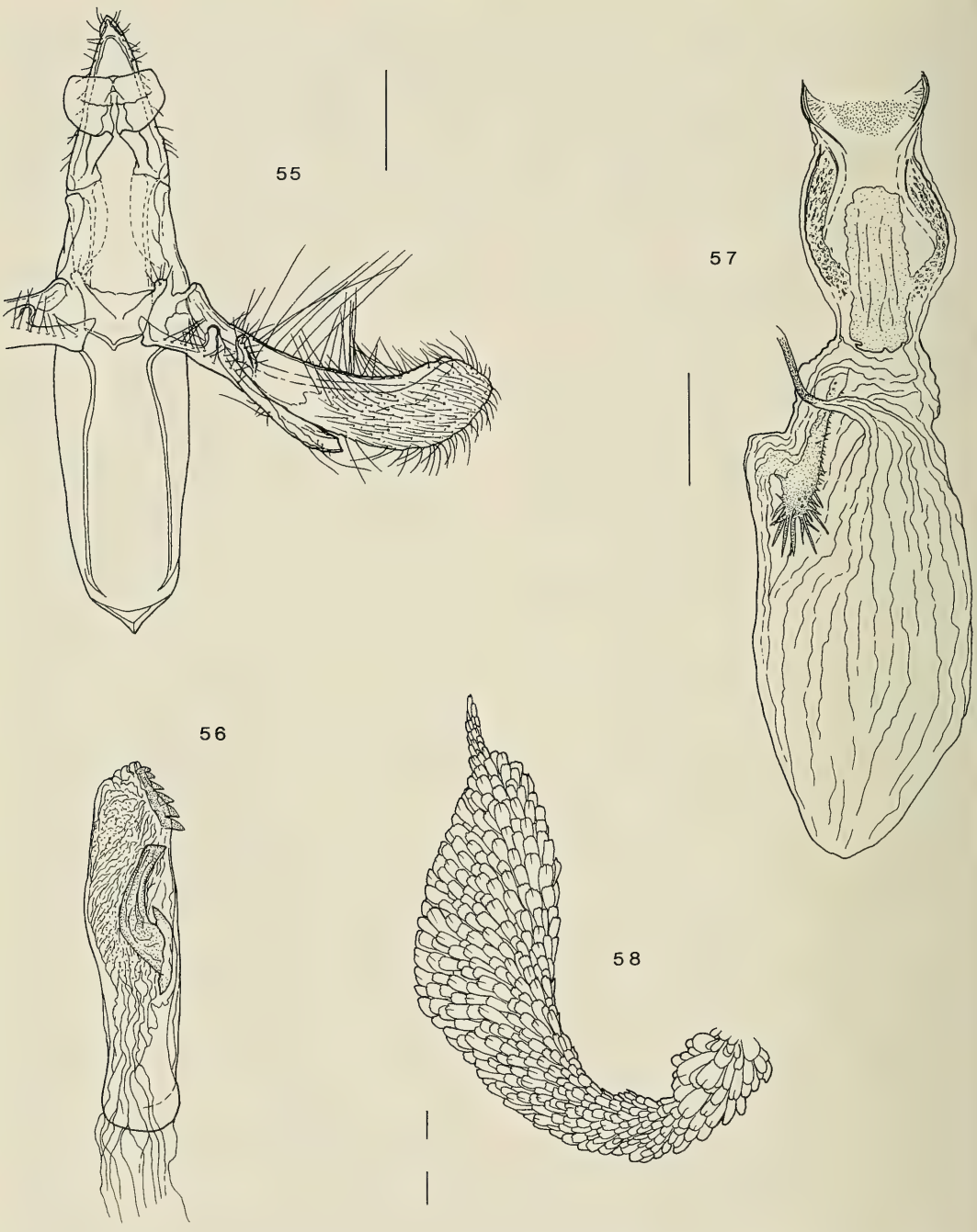
and the Latin suffix *-ensis* (denoting place, locality).

***Zamagiria rawlinsi* Neunzig, new species**
(Figs. 13, 55–58)

Type locality.—Azua, east side of crest Sierra Martin Garcia, 7 km WNW Barrero (12-21N, 70-58W), 860 m, Dominican Republic.

Diagnosis.—The male of *Z. rawlinsi* has an elongate-oval, convex structure on the upper, basal half of the forewing with an associated concavity and tuft of sex-scales on the underside. Many phycitine males have sex-scales on the underside of the forewing, usually located along the costa of the wing, and occasionally elsewhere on the wing, but the only other phycitine that I am aware of that has a tuft of sex-scales located in a position similar to that seen in *Z. rawlinsi* is *Anegcephalesis arctella* Ragonot. The sex-scales of *arctella,* however, do not have the additional elongate-oval structure present in *Z. rawlinsi.*

Description.—Length of forewing 11.5–13.0 mm. Head of male with frons and vertex grooved and with tufts of brown and reddish brown scales arising from anterior of frons, posterior of vertex brownish red; head of female with frons and vertex simple, fuscous or pale brown dusted with white; antenna of male with basal sinus in shaft, covered by strongly developed scale tufts; antenna of female simple; labial palpus of male upcurved (Fig. 58), segment 1 white basally, segment 2 long, concave on inner surface to hold maxillary palpus, fuscous and/or reddish brown dusted with white (some specimens also with a few black scales), segment 3 small, color of segment 2; labial palpus of female upcurved, fuscous dusted with white (some specimens also with a few brownish red scales); maxillary palpus of male with scaling aigrette-like, dark pink; maxillary palpus of female, simple, fuscous and white. Thorax with collar of male purplish brown to reddish brown (with brownish red or black scales in some specimens); dorsum of thorax of male purplish brown or fuscous washed with brownish red posteriorly; male with lateral part of thorax (particularly near base of wing) and dorsolateral aspects of base of abdomen red or brownish red (this feature easily seen with the unaided eye); collar and dorsum of thorax of female fuscous or reddish brown dusted with white. Forewing with ground color fuscous or dark brownish purple; male with median and terminal areas moderately dusted with white and with approximately basal 1/3 of wing dark; female with wing more uniform, generally, moderately dusted with white; subbasal ridge of mostly black, raised scales; male with black, elongate-oval convexity bisecting scale ridge; antemedial line white, rather indistinct (particularly in male), bordered distally with black; postmedial line white, moderately distinct; discal spots moderately distinct, black, fused; scattered reddish brown or purplish brown scales over most of wing and usually some patches or groups of reddish brown or purplish brown scales; underside of wing of male with strongly developed patches of red or brownish red scales at base and along about one-third of costa, and with elongate-oval cavity containing brownish white scale tuft. Hindwing pale fuscous, darker along veins and margins of wing; underside of wing of male with strongly developed patch of red or brownish red at base. Male abdominal segment 8 with ventral scale tufts. Male genitalia (Figs. 55, 56) with uncus triangular; apical part of gnathos with broad platelike element; transtilla absent; juxta sclerotized, platelike with divergent setiferous lateral arms; valva broadest towards apex with costal margin concave, sacculus about one-half length of rest of valva, more or less straight, pointed; aedoeagus with row of thornlike spines towards apex and large curved cornutus; vinculum longer than greatest width. Female genitalia (Fig. 57) with ductus bursae enlarged basally and much of remainder of ductus bursae also enlarged into second more anterior bulge; both broadened parts well sclerotized, es-



Figs. 55–58. Male and female genitalia and male labial palpus of *Zamagiria rawlinsi*. 55, Male genitalia, aedoeagus omitted. 56, Aedoeagus. 57, Corpus bursae, ductus bursae and ductus seminalis. 58, Labial palpus. (All scale lengths 0.5 mm.)

pecially laterally; corpus bursae membranous with strongly spined elongate signum in posterior of corpus bursae; ductus seminalis from about middle of corpus bursae.

Material examined.—♂ (holotype), Azua, east side of crest, Sierra Martin Garcia, 7 km WNW Barrero (18-21N, 70-58W), 860 m, cloud forest adjacent to disturbed forest, 25–26 July 1992, Y. D. T. R., genitalia slide 3683 HHN; 1 ♀ (paratype), La Vega Province, Constanza, 1164 m, Hotel Nueva Suiza, 29 May 1973, D. & D., genitalia slide 3890 HHN; 1 ♀ (paratype), Pedernales, 26 km W Cabo Rojo, 760 m, 17 July 1987, R. D.; 1 ♀ (paratype), La Independencia, 15 km NE Los Arroyos (Pedernales), summit of Sierra de Baoruco, 2260 m, 19 July 1987, D. R.; 1 ♀ (paratype), Pedernales, 9.7 km NE Los Arroyos, 2070 m, 15–16 July 1990, R. Y. T.; 8 ♂, 15 ♀ (paratypes), Pedernales, 5 km NE Los Arroyos (18-13N, 71-45W), 1680 m, 17–18 July 1990, Y. R. T., genitalia slides 3681 HHN, 3682 HHN; 1 ♀ (paratype), Independencia, Sierra de Neiba just south of crest, 5 km NNW Angel Feliz (18-41N, 71-47W), 1780 m, 13–15 October 1991, R. D. Y. T., genitalia slide 3680 HHN; 1 ♂ (paratype), Independencia, Sierra de Neiba near crest, 5.5 km NNW Angel Feliz (18-41N, 71-47W), 1750 m, 21–22 July 1992, R. T. Y. D., genitalia slide 3679 HHN; 2 ♂ (paratypes), same collection data as holotype; 1 ♂ (paratype), La Vega-Monsenor Nouel, Loma El Casabito, summit (19-03N, 70-31W), 1390 m, cloud forest, 19–23 November 1992; R. K. D. T.; 1 ♀ (paratype), Puerto Plata, Pico El Marazo, north slope near summit (19-41N, 70-57W), mesic deciduous forest, 910 m, 28 November 1992, R. D. K. T., genitalia slide 3684 HHN.

Etymology.—*Zamagiria rawlinsi* is named to honor John E. Rawlins (CMNH) whose efforts in extensively collecting Lepidoptera in the Domincan Republic, and whose enthusiastic assistance in providing specimens for study, have, in large measure, made this study possible.

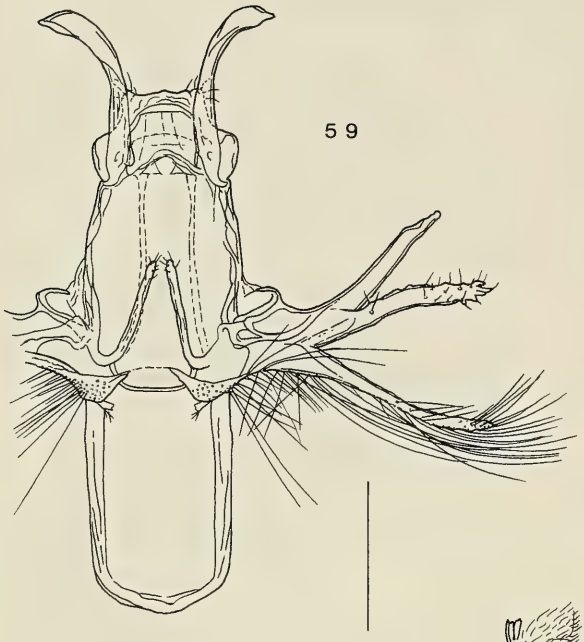
Caristanius tripartitus Neunzig, new species

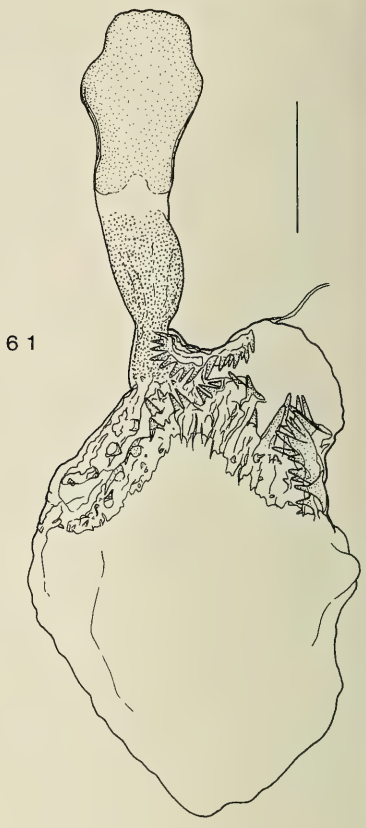
(Figs. 14, 59–62)

Type locality.—La Vega Province., Hotel Montana, ca. 520 m, 10 km NE Jarabacoa, Dominican Republic.

Diagnosis.—The appearance of the tripartite valva of the male genitalia (Fig. 59) is diagnostic. Other *Caristanius,* including the Caribbean *C. pellucidellus* (Ragonot), have the male valva divided into three parts, but the parts are not as similar to each other in size and shape as in *C. tripartitus.*

Description.—Wing length 10.0–11.0 mm. Head with frons pale brown dusted with white; vertex similar to frons (in female with faint reddish brown between antennae); male antenna (Fig. 62) with sinus and stout scale tuft on base of shaft; labial palpus pale brown to brown dusted with white; thorax with collar and dorsum pale brown and pale reddish brown to brownish red (with a very few black scales in male, and lightly dusted with white in female). Forewing with ground color pale brown to brown; most of wing moderately dusted with white, particularly in costal half, and with scattered obscure pale reddish brown scales; elongate patch of pale reddish brown or ochre on basal and subbasal inner half, and patch (or patches) of black on subbasal inner half; antemedial line white, very indistinct, its distal margin somewhat delineated by fragmented, irregular, black line; pale, elongate, reddish brown patch following antemedial line on inner half; discal spots fuscous to black, obscure; postmedial line difficult to detect; underside of wing of male without costal fold and sex-scaling. Hind wing pale fuscous. Male genitalia (Figs. 59, 60) with uncus having at ventrolateral angles pair of robust, outwardly curved sclerotized arms; gnathos absent; transtilla absent; juxta with slender, setiferous lateral lobes; valva divided longitudinally into three, slender, approximately equal-sized elements; costal element well sclerotized, without setae; middle element





Figs. 59–62. Male and female genitalia and male antenna of *Caristanius tripartitus*. 59, Male genitalia, aedoeagus omitted. 60, Aedoeagus. 61, Corpus bursae, ductus bursae and ductus seminalis. 62, Base of antenna. (All scale lengths 0.5 mm.)

with short setae arising individually from small tubercles; most anterior element (? sacculus) with many long setae; aedoeagus with slender, slightly curved cornutus; vinculum longer than greatest width. Female genitalia (Fig. 61) with ductus bursae distinctly broadened and strongly sclerotized in posterior half and with many scobinations in anterior half; corpus bursae membranous with large, elongate, curved, sclerotized and coarsely spined plates; ductus seminalis from corpus bursae near junction with ductus bursae.

Material examined.—♂ (holotype), La Vega Prov., Hotel Montana, ca. 520 m, 10 km NE Jarabacoa, 28 May 1973, D. & D., genitalia slide 3860 HHN; 1 ♀ (paratype), same collection data as for holotype, genitalia slide 3861 HHN.

Discussion.—Other *Caristanius* spp. feed as larvae on the leaves of species of *Cassia* (Fabaceae) (Heinrich 1956; Neunzig 1977, 1979). Thirty-eight species of *Cassia* occur in the Dominican Republic (Moscoso 1943) and one or more may serve as food for larvae of *C. tripartitus.*

Etymology.—The specific epithet is derived from the Latin *tri-partitus* in reference to the evenly divided, tripartite condition of the male valva.

Acknowledgments

M. A. Solis, Systematic Entomology Laboratory, U.S. Department of Agriculture (USNM), and J. E. Rawlins (CMNH) generously arranged for the loan of specimens. For critically reading a draft of this paper, I am indebted to R. L. Blinn, L. L. Deitz, and B. M. Wiegmann, all of North Carolina State University.

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FOSSIL SCOLEBYTHIDS (HYMENOPTERA: SCOLEBYTHIDAE) FROM LEBANESE AND DOMINICAN AMBER

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Abstract.—The first two fossil species of Scolebythidae are described: **Libanobythus milkii,** n. gen., n. sp., from Lebanese amber of Early Cretaceous, and **Dominibythus inopinatus,** n. gen. n. sp., from Dominican amber of Late Eocene to Late Oligocene. The relationships of these tax to extant scolebythids are discussed.

The family Scolebythidae is a morphologically unusual and very rarely encountered group of chrysidoid wasps that has been only recently recognized (Evans 1963). The family may be immediately identified by its unique apomorphies that include a remarkably modified propectus. In the extant fauna, it is represented by three species, viz. *Clystopsenella longiventris* Kieffer, *Scolebythus madecassus* Evans, and *Ycaploca evansi* Nagy. The fossil *Cretabythus sibiricus* Evans was tentatively assigned to this family by Evans (1973), but is apparently not closely related to Scolebythidae (Rasnitsyn 1988). We describe below the first unquestionable fossil scolebythids, *Libanobythus milkii* gen. et sp. n. from Lebanese amber of Early Cretaceous age (135–120 Ma) and *Dominibythus inopinatus* gen. et sp. n. from Dominican amber of Late Eocene to Late Oligocene age (40–15 Ma). Considering the rarity of the family today, its occurrence in both ambers is noteworthy, particularly its presence in the Early Cretaceous.

Materials and Methods

Morphological terms used here are those in general use in aculeate systematics (e.g. Michener 1944, Richards 1977). The terminology and modified drawing conventions of Mason (1986) for stages of venational reduction are used. For brevity, the seven metasomal tergites and eight sternites are referred to as TI–TVII and SI–SVIII, respectively. All illustrations, except those of the male genitalia, were made with a camera lucida from specimens submerged in safflower oil to minimise optical distortion. The male genitalia of *Dominibythus inopinatus* were illustrated with an ocular grid at 160× magnification. The illustrations were refined using the Adobe Illustrator computer program (Adobe Systems Inc.).

The piece of Lebanese amber containing the holotype of *Libanobythus milkii,* like most Lebanese amber, was very fragile and contained many internal fractures before preparation. To strengthen the amber for polishing and to improve the clarity of the piece, the specimen was embedded in Ward's bioplastic. After embedding, the piece was polished down by hand as nearly as possible to the level of the fossil to improve the visibility of the wasp. The piece was then re-embedded in plastic to cover exposed portions of amber. Because of the clarity of the Dominican amber containing the holotype of *D. inopinatus,* this speci-

men was not embedded in plastic for study. [For permanent preservation of amber fossils, however, it is recommended that they be mounted in some type of clear medium to protect them from eventual oxidation that would otherwise tend to cause discoloration and cracking (Poinar 1992).] After polishing, the pieces were studied in safflower oil.

Age of the Fossils

The Lebanese amber specimen of *L. milkii* came from beds located near the mountainous villages of Jezzine and Dar al-Baidha. These beds occur in primary deposits of the Neocomian Epoch of the Early Cretaceous as well as in secondary deposits of the Barremian and Aptian stages. These deposits are dated from 120 to 135 million years old (Schlee and Dietrich 1970, Schlee and Glockner 1978).

The Dominican amber specimen of *D. inopinatus* originated from mines located in the Cordillera Septentrional, between Santiago and Puerto Plata, in the Northern Portion of the Dominican Republic. These mines are in the Altamira facies of the El Mamey Formation (Upper Eocene), which is shale sandstone interspersed with a conglomerate of well rounded pebbles (Eberle et al. 1980). Amber from these mines have been estimated by Lambert et al. (1985) to range from 15 to 40 million years old.

Characters of the Family

The fossils may be recognized as Scolebythidae by their enlarged and exposed diamond-shaped prosternum and posteriorly produced fore coxae bearing the fore trochanters laterally (Figs. 3, 6). These propectal characters are unique apomorphies of Scolebythidae (Brothers 1975, Carpenter 1986) and provide the strongest evidence for the family-group identities of the fossils. Both species also have most other apomorphies of the family listed by Brothers (1975) including a small, transverse clypeus, reduced metanotum (only visible in *D. inopinatus*), enlarged femora, and a complete lack of middle tibial spines. They also possess short, broad mandibles and venation that may be readily derived from the typical scolebythid pattern (Figs. 5, 7). Like extant scolebythids, both fossil forms have a convex and smoothly rounded first metasomal sternite that does not form an articulation with the second metasomal sternite and have a noticeably concave anterior surface on the first metasomal tergite. Like extant female scolebythids, the female of *L. milkii* possesses enlarged genae. Loss of the pronotal collar, which is another apomorphy of the family listed both by Brothers (1975) and Carpenter (1986), is present in *D. inopinatus* but not *L. milkii,* which has a less declivous and more elongate pronotum. Given this list of features, there can be no other taxonomic placement for the fossils.

As members of Chrysidoidea, the fossils possess the standard features of the superfamily including reduced forewing venation, lack of any closed cells in the hind wing (true of all Chrysidoidea except Plumariidae), 13-segmented female antennae and no jugal lobe.

Key to Scolebythid Genera

1. R1 vein of forewing complete and fusing with Rs vein apically . . . . . extant genera, see Nagy (1975) for key
– R1 vein of forewing absent, not fusing with Rs vein apically (Figs. 5, 7) . . . . . extinct genera, 2
2. Discoidal cell defined by tubular veins, pronotum longer than scutum dorsally (Fig. 5) . . . . . *Libanobythus,* new genus
– Discoidal cell absent (Fig. 7), pronotum markedly shorter than scutum dorsally (Fig. 4) . . . . . *Dominibythus,* new genus

Dominibythus Prentice and Poinar, new genus

Type and only known species: *Dominibythus inopinatus,* new species.

Generic characters.—Frons elevated between antennal sockets, with carina arising at medial margin of antennal socket and extending outward dorsally creating two slightly depressed lateral areas that receive antennal scapes (Fig. 8). Orbits converging ventrally (Fig. 8). Ocelli positioned slightly

Figs. 1–2. 1, *Dominibythus inopinatus,* lateral view of left side. 2, *Libanobythus milkii,* dorsal view. Bars = 0.5 mm.

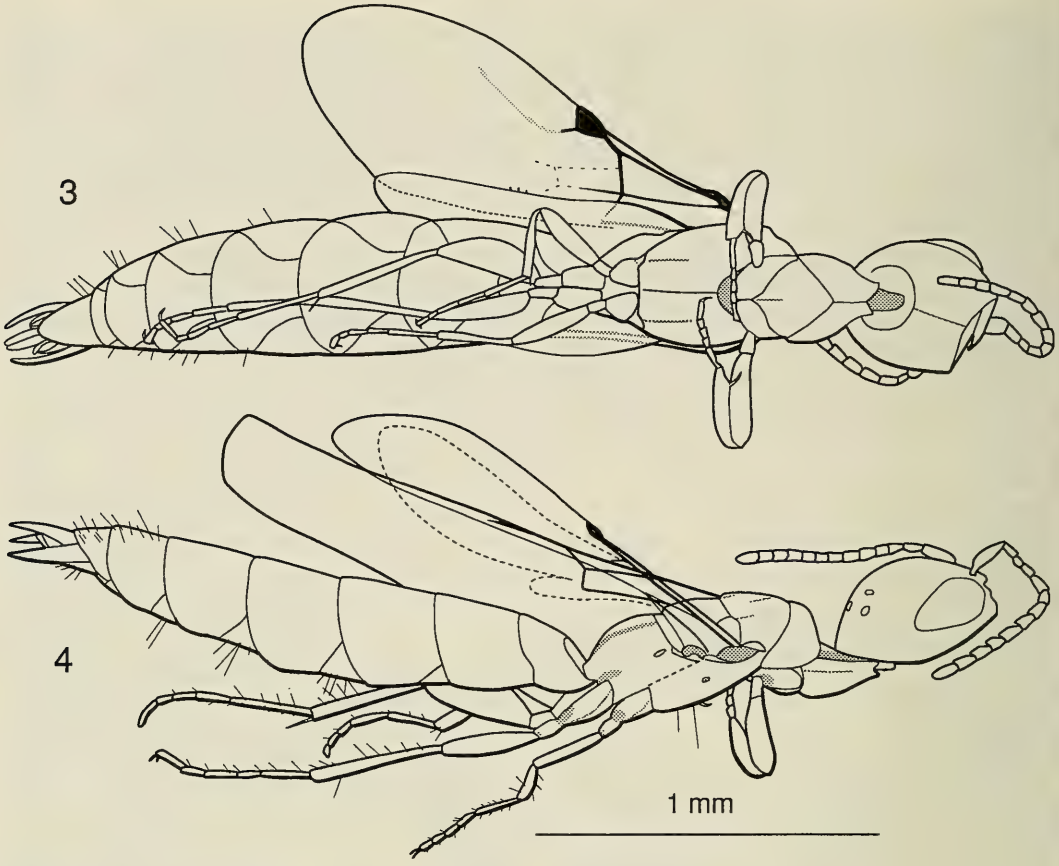
anterad of imaginary line connecting postero-dorsal margin of eyes. Clypeus conspicuously transverse, produced ventrally into a lobe that is about as wide as distance between outer margins of antennal sockets. Length of malar space equal to 0.5× basal mandibular width. Occipital carina present, at least ventrally, with gular sulcus extending along midline. Antenna arising very low on face, 13-segmented. Pronotum dorsally short, its length 0.2× length of mesoscutum, sharply declivous anteriorly; posterolateral lobes extending to tegulae. Propleuron well developed, anteriorly forming a neck separating head from pronotum, exposed dorsally. Prosternum large, diamond-shaped. Parapsidal lines long, positioned near lateral margins of mesoscutum. Notauli present only anteriorly. Mesoscutellum produced posteriorly as narrow rim overlying anterior margin of metanotum. Mesopleural signa comparatively long, extend-

ing from very near posterior margin of mesopleura half the distance to the antero-ventral margin of the mesopleura. Scrobe present and well-developed. Mesosternum simple, not produced as lamella over coxa. Metanotum short, its length 0.25× length of mesoscutellum. Propodeum with median longitudinal depression extending from anterior margin to near posterior rim, without evident metapostnotum dorsally. Tibial spur formula 1-1-1. Tarsal claws simple. Fore wing venation with R1 completely lacking; Rs+M as spectral vein; apical portion of Rs represented by an exceedingly light nebulous vein; first free abscissa of Cu nebulous, apically becoming spectral (Fig. 7); stigma conspicuous, slightly convex on costal margin. Hind wing venation reduced to costal vein extending 0.3× length of wing and to very base of anal vein. Jugal lobe absent. Metasoma with no constriction between first and second segments. Metasomal tergites dorsally comparatively flat in cross-section, sternites somewhat convex in cross-section; male with seven exposed tergites and eight exposed sternites. First metasomal tergite with a well formed depression on the anterior face fitting the posterior portion of the propodeum. First metasomal sternite evenly convex apically, not forming an articulation with SII.

Derivation of name.—The name *Dominibythus* is a combination of Dominican (referring to the Dominican Republic) and Scolebythus.

Dominibythus inopinatus Prentice and Poinar, new species (Figs. 1, 3, 4, 7–9)

Male.—Length 2.8 mm. Color: Head, mesosoma and metasoma brown; legs, antennae, mouthparts and genitalia tan; wings clear, veins tan. Sculpture and vestiture: Head smooth, with microscopic punctures that are about 2 ocellar diameters apart, with no visible vestiture; mesosomal cuticle microscopically areolate, with a few erect setae on venter; metasoma with some sparse, erect setae, 1–2 mid antennal flagellomeres in length; most metasomal setae on more apical segments. Fore, mid, and especially hindtibiae bearing setae whose length nearly averages that of tarsomere II. Fore and hind wing bearing minute, evenly spaced setae on apical half. Structure: Head 0.45 mm from vertex to ventral margin of clypeus and 0.45 mm in maximal width. Frontal line present, extending from near anterior ocellus to between antennal sockets. Ocellar triangle slightly elevated; ocello-ocular distance slightly greater than width of ocellar triangle; distance between lateral ocelli 1.5× diameter of a lateral ocellus. Width of gena 0.5× width of eye in lateral view. Proboscidial fossa short and wide, width 6× length. Occipital carina separated from proboscidial fossa by approximately the length of 4 mid-flagellomeres. Scape somewhat flattened in cross-section, length, including radicle, approximately 2× greatest width. Length of pedicel 2× length of first flagellomere, slightly less than length of scape without radicle; length of flagellomere II approximately 1.5× length of flagellomere I; flagellomeres III–X approximately equivalent in length and slightly longer than flagellomere II; length of flagellomere XI 1.3× length of flagellomere X. Mandibles relatively short, subapical teeth not visible although ventral one well produced apically. Mesosoma 0.9 mm in length. Mesoscutum about as long as mesoscutellum; median longitudinal impression evident. Epicnemial sulcus apparently present below pronotal lobe and extending ventrally to midline near very anterior margin of mesopleura. Propodeal spiracle with well-developed operculum and placed very near propodeal anterior margin, completely on lateral propodeal face. Fore femur robust, length slightly less than 3× width, widest distally; length of hindfemur slightly more than 3× width. Fore tibia about as long as fore femur; mid and hind tibiae slightly longer than respective femora. Length of hindtibial spur about 0.5× length of hindbasitarsus. Fore tarsus about as long as fore tibia; mid and hind tarsi longer than



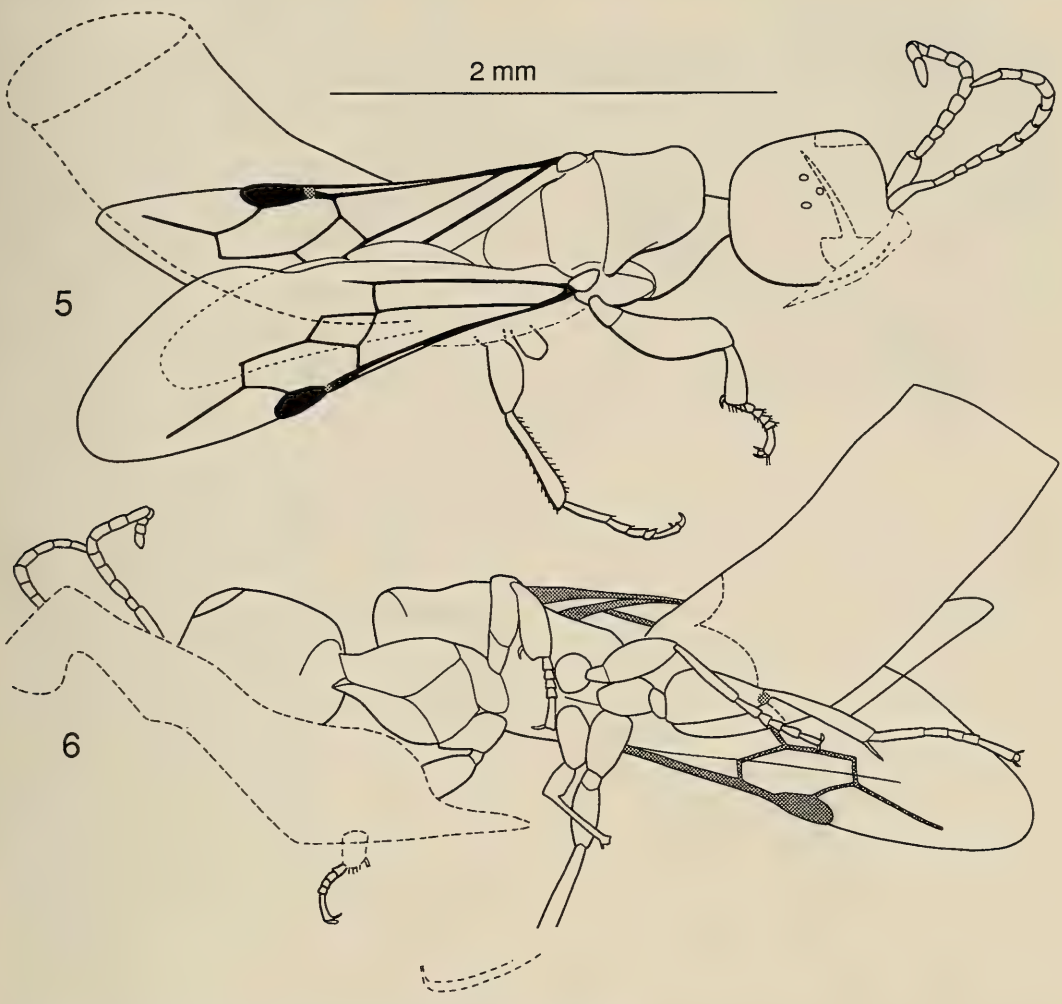
Figs. 3–4. *Dominibythus inopinatus.* 3, Ventral view. 4, Dorsolateral view.

their respective tibiae. Fore wing 1.4 mm in length; costal vein bearing a number of relatively well-developed setae that form a fringe approximately as wide as the prestigma. Hind wing with three hamuli; length of vannal lobe approximately 0.3× length of hind wing; posterior margin of hind wing bearing a fringe of well-developed setae that is as wide as the fringe on the costal margin of the fore wing. Metasoma elongate, 1.6 mm long (excluding genitalia). Length of second metasomal tergite approximately 1.3× length of TI. Length of first metasomal sernite about 1.5× length of TI. Subgenital plate clearly exposed and entirely convex on apical margin (Fig. 9). Aedeagus extending slightly beyond imaginary line drawn between apices of gonapophyses; gonapophyses bearing at least a few, very fine setae apically (Fig. 9); gonapophyseal setae about equivalent to width of gonapophyses near tip in length. The male genitalia of the holotype are exposed. In the normal position they would be concealed by TVII and SVIII.

Female.—Unknown.

Derivation of name.—The Latin *inopinatus,* meaning unexpected, refers to the seemingly improbable discovery of this wasp in Dominican amber given the rarity of the family in the extant fauna.

Material examined.—Holotype ♂: a superbly preserved wasp in Dominican amber with locality data as described under Age of the Fossils. It is in a clear piece of amber approximately 7 mm in length (specimen #7594, Smithsonian Dominican amber Brodzinsky/Lopez-Penha collection).

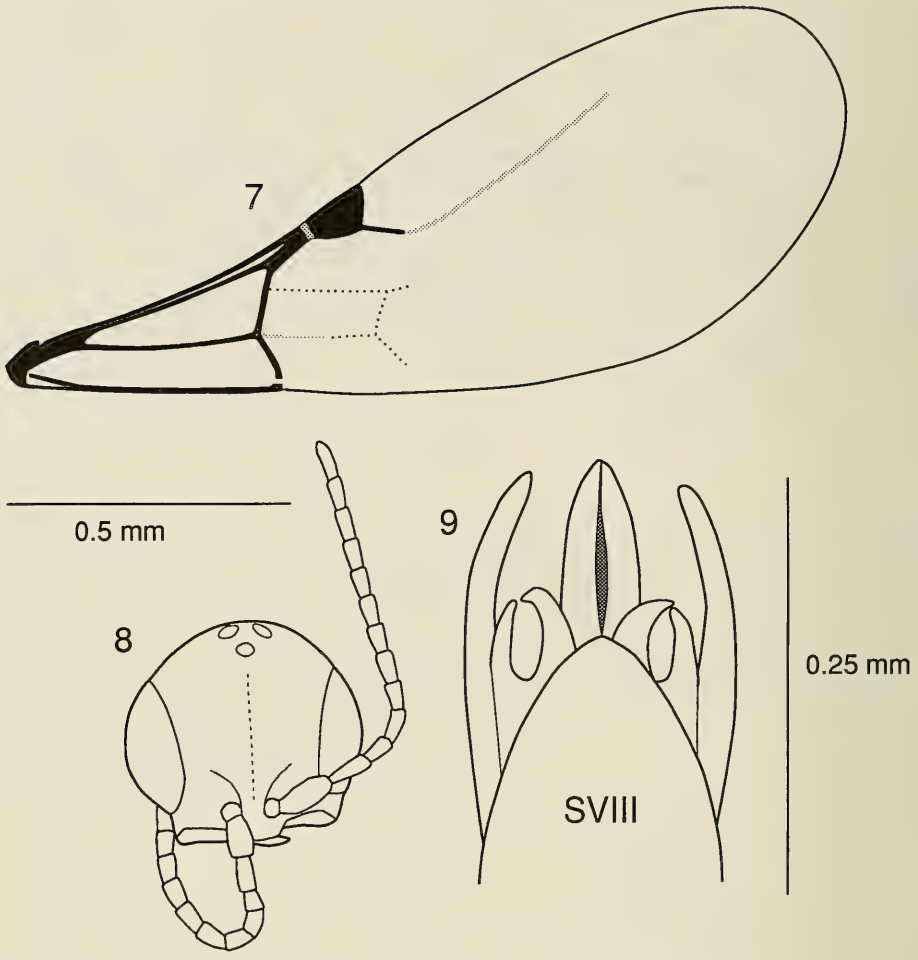


Figs. 5–6. *Libanobythus milkii.* 5, Dorsal view. 6, Ventral view.

Libanobythus Prentice and Poinar, new genus

Type and only known species: *Libanobythus milkii,* new species.

Generic characters.—Frons not elevated between antennal sockets with no evident carinae. Inner orbits evenly convex, closest near middle. Lateral ocelli positioned slightly posterad of imaginary line connecting postero-dorsal margin of compound eyes. Clypeus very short, transverse. Gena well developed, wider than eyes in lateral view. Occipital carina present, at least ventrally. Antennae placed very low on face, 13-segmented. Mandibles short, broad. Maxillary and labial palpi apparently 4-segmented. Pronotum nearly 1.5× as long as mesoscutum, not sharply declivous anteriorly; postero-lateral lobe of pronotum extending to tegula. Propleura well developed, anteriorly forming a neck that separates head from pronotum. Prosternum exposed and diamond-shaped. Parapsidal lines and notauli apparently absent. Mesosternum simple, not produced as lamellae over mid coxa. Tibial spur formula apparently 1-1-1. Tarsal claws simple. Forewing with vein R1 completely lacking; vein Cu absent beyond 1m-cu cross-vein; apical abscissa of anal vein slightly longer than cross-vein cu-a;



Figs. 7–9. *Dominibythus inopinatus*. 7, Right forewing, nebulous veins indicated by stiplings, spectral veins indicated by dotting. 8, Face. 9, Male genitalia, ventral aspect with outline of last sternum indicated.

apical portion of vein Rs extending close to costal margin, its length 3× length of crossvein 2r-rs, tubular throughout; stigma slightly convex on costal margin (Fig. 5). Hind wing vannal lobe extending 0.4× length of hindwing; jugal lobe absent. No constriction between first and second metasomal segments; segments wider than high. First metasomal tergite with depression fitting end of propodeum. First metasomal sternite evenly convex apically, not forming articulation with SII.

Derivation of name.—*Libanobythus* is a combination of the names Lebanon and Scolebythus and is in reference to the country of origin of the fossil.

Libanobythus milkii Prentice and Poinar, new species

(Figs. 2, 5, 6)

Female.—Body length approximately 4 mm not including apical metasomal segments which are missing from holotype. Color: Head, mesosoma and metasoma piceous; legs, antennae and mouthparts brown; wings clear, radial vein and stigma brown, other veins brownish-yellow. Sculpture and vestiture: Head smooth, with at least a few short, erect setae on genae. Pronotum and mesonotum smooth; pronotum bearing some erect setae approximately 0.05 mm in length. Metasoma bearing nu-

merous scattered setae, at least ventrally, approximately 0.1 mm in length. Legs with numerous scattered setae from 0.05 to 0.1 mm in length, best developed on mid and hind tibiae. Wings without evident setae. Hindwing bearing a fringe of setae approximately 0.02 mm in width. Fringe of same width extending from fore wing costal vein. Structure: Head 0.65 mm wide, 0.75 mm from vertex to ventral margin of clypeus. Width of ocellar triangle about equal to ocello-ocular distance; distance between lateral ocelli about 2.5× diameter of a lateral ocellus. Scape flattened, length including radicle, approximately 2.5× greatest width. Pedicel moderately long, its length 2× length of first flagellomere. Flagellomeres II–X nearly equal in length, approximately twice as long as flagellomere I; length of flagellomere XI 1.5× length of flagellomere X. Mesosoma, including propleura, approximately 1.4 mm in length. Pronotum subequal to mesoscutum in length. Fore femur robust, 2.4× as long as wide; mid femur robust, length slightly more than 2× width; hind femur very robust, length slightly less than twice greatest width. Fore tibia slightly shorter than fore femur; mid and hind tibiae approximately equal to respective femora in length. Length of hind tibial spur less than 0.5× length of hind basitarsus. Fore tarsus shorter than fore tibia; mid and hind tarsi longer than their respective tibiae. Fore wing 2.4 mm in length. Hind wing with four hamuli. Length of vannal lobe slightly less than 0.4× total hind wing length.

Male.—Unknown.

Derivation of name.—This species is named for Dr. Raif Milki.

Material examined.—Holotype ♀: a not well preserved specimen of an almost entire wasp from Lebanese amber with locality data as described under Age of the Fossils. The fossil is covered with numerous small air bubbles and cracks that obscure many details. The wasp is also lacking the last few metasomal segments. It is embedded in a piece of plastic measuring 1 cm × 1 cm × 0.5 cm. The specimen is part of Dr. Raif Milki's Lebanese amber collection maintained at the American University of Beirut.

Preservation.—The specimen lacks the end of the metasoma, but may be identified as a female due to its overall robust form, powerfully built legs (particularly the fore femora) and enlarged genae. Male scolebythids are more delicately built, with slenderer legs and less well developed genae. Because of the state of preservation of this wasp, its description is not entirely comparable with that of *D. inopinatus*.

Relationships

The elongate pronotum that retains a pronotal collar in *Libanobythus milkii* suggests a sister-group relationship between this species and other known Scolebythidae since the loss of the collar in other scolebythids is very likely derived within Chrysidoidea (Brothers 1975, Carpenter 1986). This sister-group relationship would not be unexpected given the age of the fossil, but, if true, means the complete absence of vein R1 in both *L. milkii* and *D. inopinatus* is convergent. The elongate pronotum and presence of a pronotal collar in *L. milkii* provides further support for the views of Brothers (1975) and Carpenter (1986) whose cladistic analyses indicated that the loss of the pronotal collar in Plumariidae (most probably the sister-group to other Chrysidoidea (Brothers 1975, Carpenter 1986)) and Scolebythidae is convergent. The alternative, that the absence of the collar in Plumariidae and some scolebythids is homologous and thus a groundplan feature of Chrysidoidea, as Koenigsmann (1978) believed, is now especially unlikely.

Dominibythus inopinatus appears to be most closely related to *Ycaploca evansi* as indicated by the presence in both taxa of a frontal prominence between the antennae that is marked laterally by two dorsally diverging carinae (Fig. 8). This feature is not evident in any of the other species of Scolebythidae. *Dominibythus inopinatus* also shares a well developed clypeal lobe, pro-

podeal groove and evenly convex subgenital plate with *Ycaploca,* but these features are also present in *Scolebythus.* An apparent tibial spur formula of 1-1-1 may be an additional character linking *D. inopinatus* with *Y. evansi* since *Scolebythus* and *Clystopsenella* have the ancestral tibial spur formula of 1-2-2. *Dominibythus inopinatus* may be distinguished from *Y. evansi,* and other extant scolebythids, by its much more reduced wing venation which does not include a complete marginal, submarginal or discoidal cell, by its more strongly diverging frontal carinae, by its lack of well developed notauli and by its lack of an evident metapostnotum on the propodeum.

Discussion

The addition of two new monotypic fossil scolebythid genera to the three extant monotypic genera might seem to unnecessarily clutter this small family with genera. However, on phenetic grounds, the recognition of five genera is justified. Neither fossil species may be placed in a currently defined genus and both are as morphologically distinct as any of their extant relatives. This taxonomic arrangement simply reflects the relictual status of this group and accords with the great range in age of the included species. Unfortunately, this scheme does not represent any cladistic or phenetic relationship between the species.

When Evans (1963) described the family, he speculated that the species attacked wood-boring beetle larvae based on their possession of some characteristics reminiscent of wasps, such as Aulacidae, having such a biology. Features mentioned by Evans (1963: 14) are "the broad mouth opening and powerful mandibles, the reduced clypeus, and the strong malar space; on the thorax the elongate proepisterna, perhaps the large prosternum, and the flattened coxae." Evans (1963: 8) also identified a well developed proepimeron in scolebythids that he stated as ". . . completely set off by sutures from the proepisterna." From studying his figures and specimens of *Clystopsenella longiventris* and *Ycaploca evansi,* as well as the fossil material, however, it appears that this "so-called" proepimeron is actually a part of the fore coxa that extends as a lobe basad of the insertion of the trochanter. Based on collection data from a number of specimens of *Y. evansi,* Nagy (1975) and Brothers (1981) have essentially confirmed Evans' (1963) original speculation. The information indicates that scolebythids develop on wood-boring beetle larvae (Cerambycidae) that are attacked in their host beetle's burrows. Of interest is the possibility that they are gregarious parasitoids (Brothers 1981), which, if true, is unusual for an aculeate. Given the nearly identical modifications of the fossil scolebythids to their extant relatives, it is very likely that they, too, attacked wood boring beetle larvae in the same manner as living scolebythids.

In addition to the features listed by Evans, other peculiar apomorphies of the family include the convexity of SI, the lack of an articulation between SI and SII, the deep concavity in TI that fits the end of the propodeum, the transverse flatness of the tergites as opposed to the convexity of the sternites, and the overall length of the metasoma. Possibly these features facilitate movement through their host's burrows, although it is curious that each modification would seem to allow the metasoma to be more freely articulated dorsad. Possibly this is an alternative means for bringing the sting to bear on the prey; if true, this would differ from the movement of other aculeate wasps which universally articulate the metasoma downward and below the body for stinging prey. If anything, the peculiar modifications of the propectus enhance this idea, for the form of the propectus allows the head to be strongly directed dorsad (as seen in the fossils and pinned scolebythids), and the fore legs to be brought forward; this could allow the mandibles and forelegs to grip the prey while stinging with the metasoma held up and over the body of the wasp.

By attacking wood boring beetle larvae, scolebythids are exposed to places (such as the bases of resin producing trees) where they may be trapped in resin having the possibility of subsequent fossilization. Thus, like many other aculeate wasp taxa that have been found in amber, the biology of scolebythids increases the probability that they may be found in amber. This may partially explain their occurrence in both Lebanese and Dominican ambers, although it is also possible that the family may have been more common in the geologic past.

Acknowledgments

We thank Dr. Karl V. Krombein of the National museum of Natural History, Smithsonian Institution, Washington, DC, for lending us specimens of *Scolebythus madecassus, Clystopsenella longiventris* and *Ycaploca evansi* for study. We also thank Dr. A. P. Rasnitsyn of the Paleontological Institute, Russian Academy of Sciences, Moscow, for the unique specimen of *Cretabythus sibiricus,* and Mr. Gary Hevel of the National Museum of Natural History for the Dominican amber specimen of *Dominibythus inopinatus.*

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98(4), 1996, pp. 812–817

A NEW SPECIES AND GENERIC PLACEMENT FOR THE MISIDENTIFIED TYPE SPECIES OF *EPICLEA* DYAR, 1905 (LEPIDOPTERA: LIMACODIDAE)

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Abstract.—A Mexican species of Limacodidae has remained undescribed, hidden under the name *Epiclea elaea* (Druce) 1887 because of an improper type label on a specimen now in the collection of The Natural History Museum, London. The species is described as ***Monoleuca longifascia***, new species, and is placed in *Monoleuca* based on a number of putative synapomorphies with the type species *Monoleuca semifascia* Walker.

Key Words: *Epiclea, Euprosterna, Monoleuca,* Limacodidae, Type species, Mexico, mislabelled type

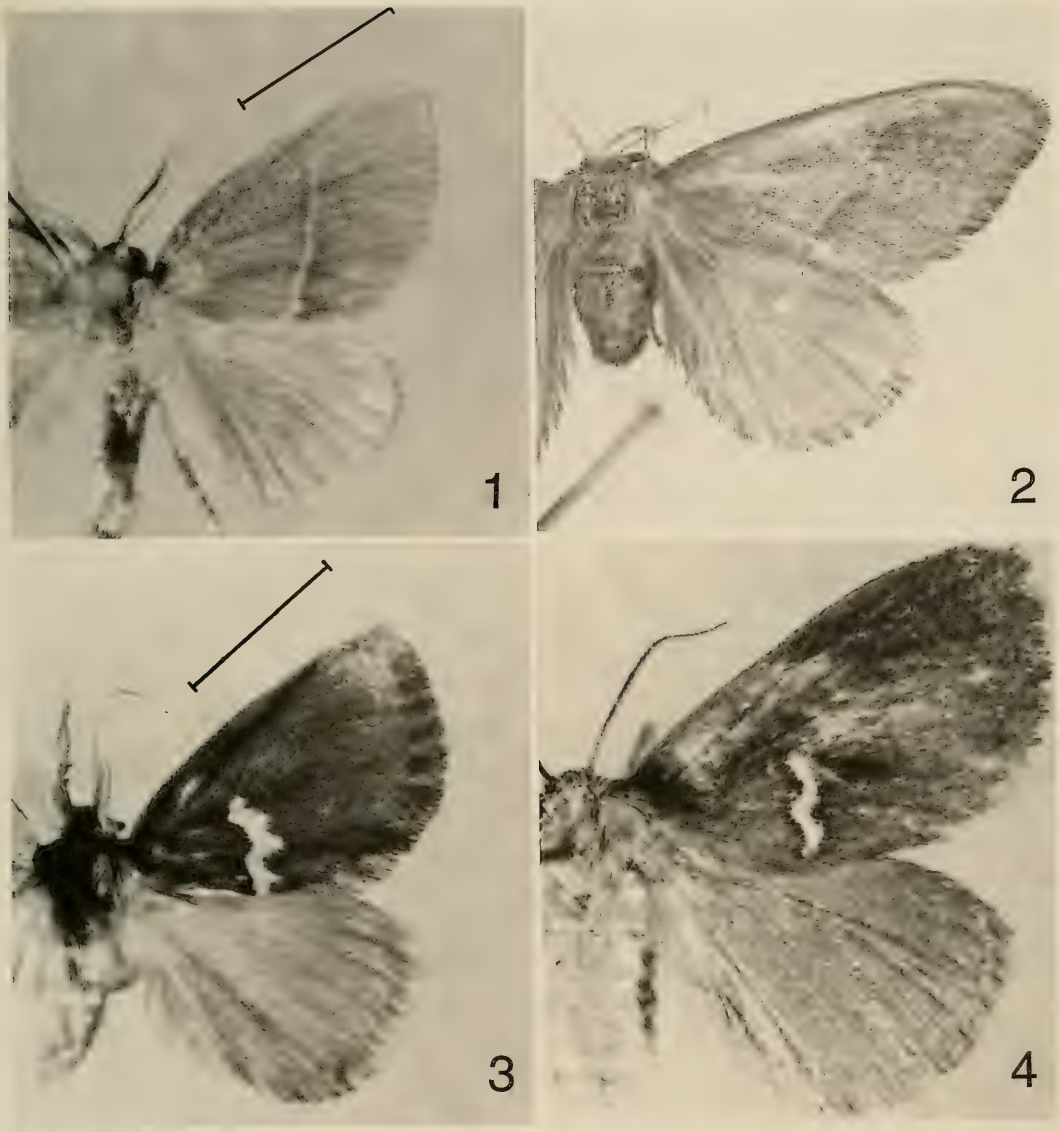
Druce (1887) described a species of Limacodidae as *Perola elaea* from Volcan de Chiriqui, Panama (Ribbe, in mus. Staudinger). Dyar (1905:373) considered a specimen labelled "type," from a mixed series of species under the name *P. elaea* in the Druce Collection, to be the type of *P. elaea.* Druce's specimen, now in the collection of The Natural History Museum, London, is clearly not the type of *P. elaea* but an unnamed species from Jalapa, Mexico (collected by M. Trujillo). Dyar (1905:377) recognized that a second species in Druce's mixed series matched the figure of *P. elaea* in Druce (1887), although he named it *Euprosterna elaeasa* because he assumed the other species to be *elaea* (see "Discussion" below). A further problem arose when Dyar used the mislabelled "*elaea*" as a basis for describing a monotypic genus *Epiclea* (Dyar 1905:373). Recently, *Epiclea* Dyar was synonymized under *Euprosterna* Dyar 1905 (Becker and Epstein 1995), since true *elaea* belongs in *Euprosterna,* and *Euprosterna elaeasa* was synonymized under *elaea* Druce (Epstein and Becker 1994). The purpose of this treatment is to describe the Mexican species, which has remained without a name and place it in a genus.

Specimens examined were from: The Natural History Museum, London (BMNH); National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM); Natural History Museum of Los Angeles Co., CA (LACM); Vitor O. Becker Collection, Brasilia, Brazil (VOB); Carnegie Museum of Natural History, Pittsburgh, PA (CMNH). The holotype and five paratypes will be deposited in the collection of Instituto de Biología, Universidad Nacional Autonoma de Mexico, Mexico City, D.F. (UNAM).

Monoleuca longifascia Epstein, New species

Diagnosis.—Combination of medial band on forewing, male antennae with broad pectinations to near apex (Fig. 1), fused R_3 and R_4 (Fig. 5), and two hind tibial spurs separate this species from all other known species of limacodids in the Neotropics.

Adult (Figs. 1, 2).—*Head:* Male antenna bipectinate to 3/5 from base; longest pectinations around twice length of antennal



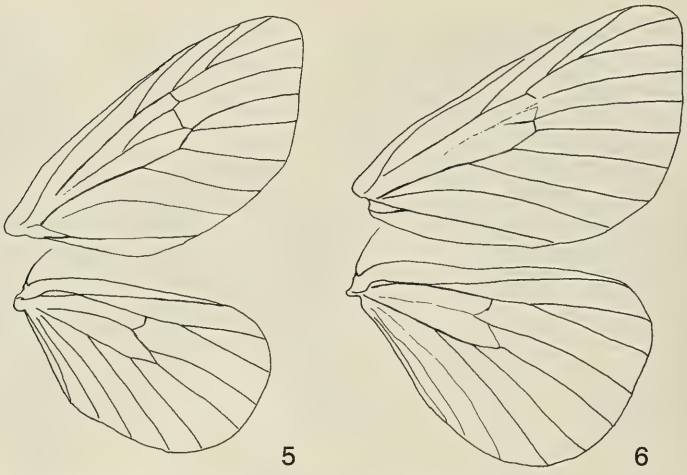
Figs. 1–4. 1, Holotype of *Monoleuca longifascia,* male wing pattern (UNAM) (forewing 9 mm, scale bar = 5 mm). 2, *M. longifascia,* female wing pattern (USNM) (forewing 15 mm) (photo by V. Krantz). 3, *M. semifascia,* male wing pattern (USNM) (forewing 10 mm, scale bar = 5 mm). 4, *M. semifascia,* female wing pattern (forewing 13.5 mm).

segments. Female antenna filiform. Third labial palpal segment oval, connected to apex of second palpal segment; haustellum weakly developed.

Legs: Hind tibia with one pair of spurs (incorrectly reported as being without spurs by Dyar [1905a, 1935]).

Forewing: Length: 8–11 mm male, 15 mm female. Tawny with narrow buff colored medial band, parallel to outer margin from inner margin to costa; suffused with lighter scales on basal area in some specimens, fringes without checkered appearance; R_3 and R_4 fused, connected to R_5 (Fig. 5).

Hindwing: Unmarked, similar hue to FW.



Figs. 5–6. Male wing venation. 5, *Monoleuca longifascia.* 6, *M. semifascia.*

Male genitalia (Fig. 7): Narrow uncus triangulate in basal half and abruptly narrowed to spindle in apical half with a minute, obliquely curved claw at apex; gnathos with fused distal portion angled obliquely posteroventrad and approx. half as wide as long, extending as far to posterior as uncus, convex above and apex rounded; valva narrow beyond midpoint, extending beyond apex of uncus with dorsal margin nearly straight and ventral margin round in basal third and angled approx. 45 degrees upward to apex; juxta and transtilla simple; aedeagus with basal third upcurved to horizontal distal portion and without small distal spines; vesica without cornuti.

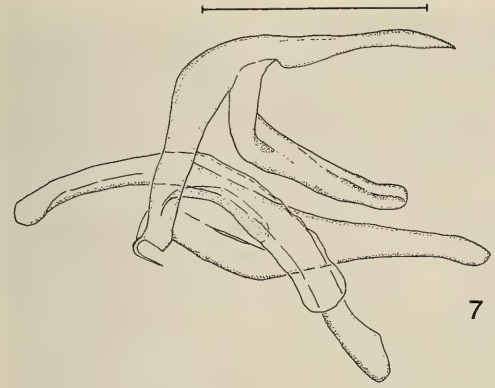
Female genitalia (Figs. 9, 10): Papillae anales narrow relative to transverse width of eighth abdominal segment; dorsum of lobes appearing elongate with angulate margins; lateral lobes on eighth segment absent (often found in limacodids); seventh segment wrinkled, extending to posterior to cover much of eighth segment. Bursa copulatrix short, only about twice length of papillae anales; ductus bursae and corpus bursae approx. equal length; ductus seminalis broadly connected to ductus bursae at distal end proximate to corpus bursae; signum absent.

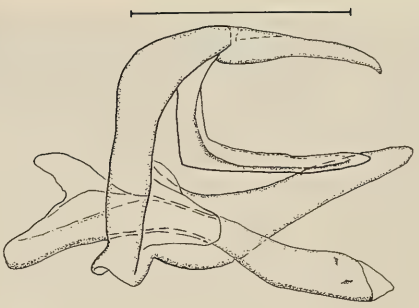
Larva.—Unknown.

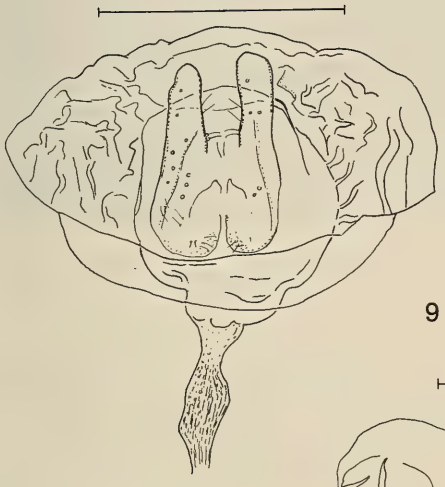
Distribution.—Mexico, at elevations ranging between 1050 and 2010 m.

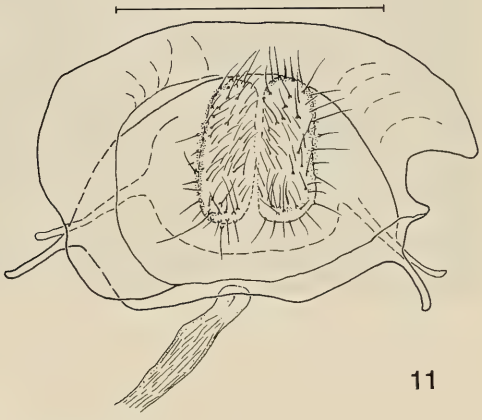
Types.—Holotype ♂, MEXICO: Tamaulipas, Rancho del Cielo, 6 km NNW Gomez Farias, 3500 ft, vii 1982 (M. A. Solis) (UNAM). Paratypes (27 specimens): 10 ♂, same data as holotype (5 each deposited in UNAM and USNM): MEXICO: 5 ♂, 1 ♀, Tamaulipas, Rancho del Cielo, 6 km NNW Gomez Farias, 3500 ft, 30 vii 1988 (Becker & Solis) (3 ♂ VOB, others USNM); 1 ♂, Hidalgo, 8 mi NE Jacala, vii 1970, 5200 ft, (Fisher) (LACM); 2 ♂, Hidalgo, 11 mi S Zimapan, 3 viii 1966 (Flint) (USNM); 1 ♂, Nuevo Laredo, 3 mi E Galeana, 5000 ft, 7–9 viii 1963 (Duckworth & Davis) (USNM); 1 ♂, Oaxaca, 2 km NW Llano Verde 2010 m, 7 July 1977 (J. E. Rawlins) (CMNH); 1 ♂, Oaxaca, 5 mi NW of Huajuapan, "UVLite," 28 July 1981 Acc. #699 (P. Jump) (LACM); 2 ♂, Hidalgo, La Montana, Tlanchinol 6000′ 11–13 May 1991 D.G. Marqua (LACM); 1 ♂, Veracruz, 8 mi SE Jalapa, 19 July 1981, UVLite Acc#681 P. M. Jump (LACM); 1 ♂, Jalapa (Schaus) (USNM) [genit. prep. 28,200; compared with Druce specimen in BMNH by Dyar]; 1 ♂, Guerrero vic. Acuitlapan, 10 mi NE Taxco 5000 ft. 4–5 September 1970 (E. M. and J. L. Fisher) (LACM).

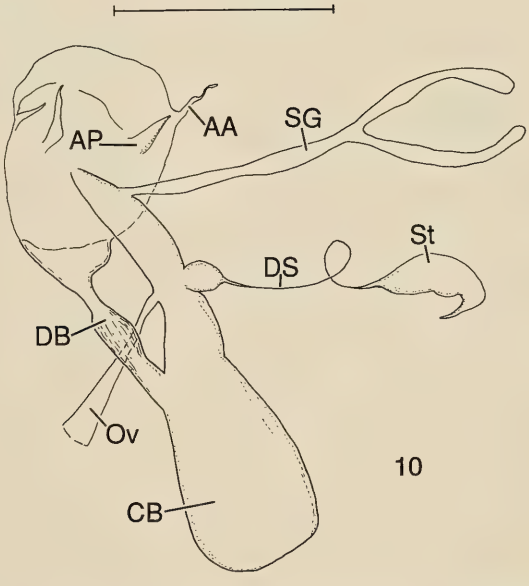
Generic placement.—Placement of *lon-*











Figs. 7–11. Male genitalia, lateral view (left valva removed) (scale length in parentheses). 7, *Monoleuca longifascia*) (2 mm). 8, *M. semifascia* (distal end of aedeagus, right) (1 mm). 9–11, Female genitalia (scale length in parentheses). 9, *M. longifascia,* ventral view, papillae anellus and segments 7–8 (1 mm). 10, *M. longifascia,* view of bursa copulatrix and associated structures (1 mm). 11, *M. semifascia,* ventral view, as for Fig. 9 (1 mm). AA = anterior apophyses; AP = posterior apophyses; CB = corpus bursae; DB = ductus bursae; DS = ductus seminalis; Ov = ovaries; SG = sebaceous gland; St = spermatheca.

Fig. 12. Eggs of *Monoleuca semifascia* covered with scales from female abdomen (photo by V. Krantz).

gifascia in *Monoleuca* Grote & Robinson is based on the following putative synapomorphies with the type species by original designation, *M. semifascia* Walker: 1) reduced papillae anales surrounded by dense clump of scales presumably used to cover eggs, as in *semifascia* (Fig. 12); 2) absence of lateral lobes on female eighth segment; 3) male antenna with long pectinations to near apex, then simple; 4) narrow valvae; 5) broad gnathos rounded at apex; 6) aedeagus curved from base to apex (rather than basal and distal portions angled). Fusion of R_3 and R_4 may also be a synapomorphy, however, more analysis will be needed to determine whether this occurred independently or in a common ancestor with *Adoneta* Clemens and *Monoleuca occidentalis* Barnes & McDunnough.

One species of neotropical Limacodidae, *M. albicollis* Forbes (= *Heuretes picticornis* Grote & Robinson), was mistakenly placed in *Monoleuca,* based only on wing pattern and the antennae. However, features of the forewing veins, larva, tibial spurs and genitalia clearly placed this species and its relatives in the genus *Heuretes* in the *Phobetron* complex (Epstein and Miller 1990).

Discussion.—In response to an inquiry by Hering in 1927, Dyar wrote that he did not record the locality data of the supposed type of *elaea* that was in Druce's collection, but if it differed from the Panama locality it would be a misidentified type. He chose to leave the "matter . . . unsettled" because "To make the change would require a new name for the species I call *elaea* Druce, invalidate the genus *Epiclea,* which would supercede [sic] *Euprosterna* and require a new genus for my conception of *Epiclea*" (H. G. Dyar Collection, Smithsonian Institution Archives).

The male genitalia of *semifascia* (Fig. 8), while very similar to those of *longifascia,* show the following subtle differences: 1) curve of aedeagus less steep from base to apex; 2) gnathos slightly concave rather than convex; 3) dorsal margin of valva

more angled upwards beyond basal fourth, making it more nearly parallel to ventral margin. The differences between female genitalia of *semifascia* (Fig. 11) and *longifascia* are more obvious, including: 1) broader papillae anales that are more fused to 8th abdominal segment along the margins and more laterally convex; 2) length of bursa copulatrix much greater than length of papillae anales; 3) corpus bursae with a signum.

The continuous medial band from the inner margin to the costa in *longifascia* is unusual in genera with close phylogenetic ties to *Euclea* Huebner. *Euclea byrne* (Dyar) is the only similar example that I know of (*Talima* species and some *Parasa* species have a continuous band, but it is submarginal rather than medial). *Monoleuca occidentalis, Adoneta* species, and a number of *Euclea* species have a band of darker scales between the subapical and postmedial spots. The band in *M. longifascia* may have resulted from a lightening of these scales between the spots in the two regions. Alternatively, the long band in *longifascia* resulted from an extension to the costa of a postmedial fascia present only below the discal cell, as in *M. semifascia.* This, however, seems less likely because it would require that an extension of the band be produced de nova.

A third species in Druce's series is a female of a Mexican species of *Euclea,* probably undescribed.

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A REVIEW OF THE STONEFLY GENUS *PARANEMOURA* (PLECOPTERA: NEMOURIDAE) AND A NEW SPECIES FROM THE NORTHEAST

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Abstract.—*Paranemoura perfecta* (Walker) is reviewed and a second species, ***P. claasseni*, n. sp.,** is described from northeastern North America. Illustrations of the adult terminalia and wings of both *P. perfecta* and *P. claasseni* are provided. A diagnosis serves to separate the two species in the male adult stage. Distributional data are included for both species and also for females that could only be determined to genus. Results show that the genus is restricted to eastern North America and that *P. claasseni* only occurs in more northern localities.

Key Words: Plecoptera, stoneflies, Nemouridae, *Paranemoura,* new species, Nearctic.

The subgenus *Paranemoura* was erected without comment by Needham and Claassen (1925) for a single species, *Nemoura punctipennis* Claassen (1923), described from New York. Ricker (1938) studied the *Nemoura perfecta* Walker type from Nova Scotia in the British Museum and placed *N. punctipennis* as a synonym under *N. perfecta.* Ricker (1952) recognized *Paranemoura* as a monotypic subgenus and gave additional distribution data for Maine and North Carolina. *Paranemoura* was raised to generic status by Illies (1966) and it has remained monotypic and relatively poorly known even though Stark et al. (1986) indicated that *P. perfecta* was known from Connecticut (Hitchcock 1974), Maine, New York, Ontario (Harper and Hynes 1971), Pennsylvania (Surdick and Kim 1976), Quebec (Ricker et al. 1968), Virginia (Kondratieff and Voshell 1979) and West Virginia.

This paper includes the description of a second species in the genus *Paranemoura* and provides distribution information for both species. *Paranemoura punctipennis* is confirmed as a junior synonym of *P. perfecta.*

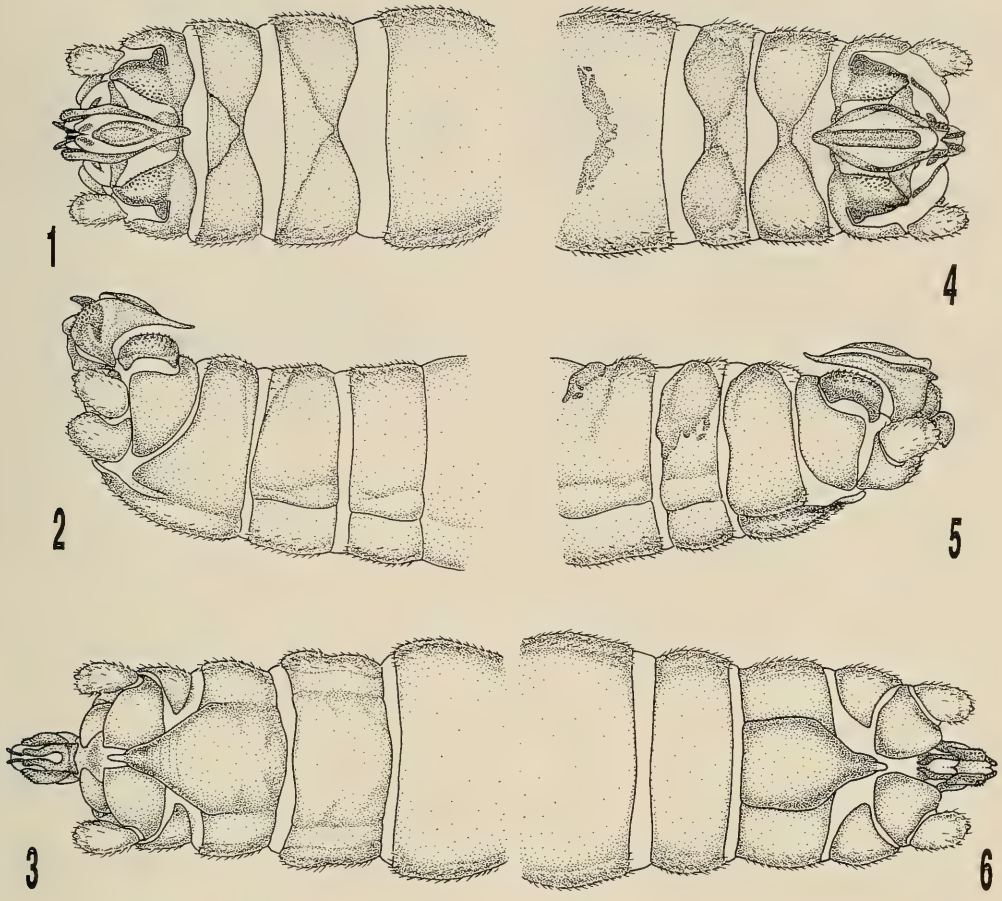
Paranemoura perfecta (Walker)
Figs. 1–3, 7–9, 13, 15

Nemoura perfecta Walker, 1852: 191. Holotype male: Nova Scotia: Redman (TNHM), examined.

Nemoura punctipennis Claassen, 1923: 291. Holotype male: New York: Axton, Adirondack Park, 12–22 June 1901 (CUIC), examined.

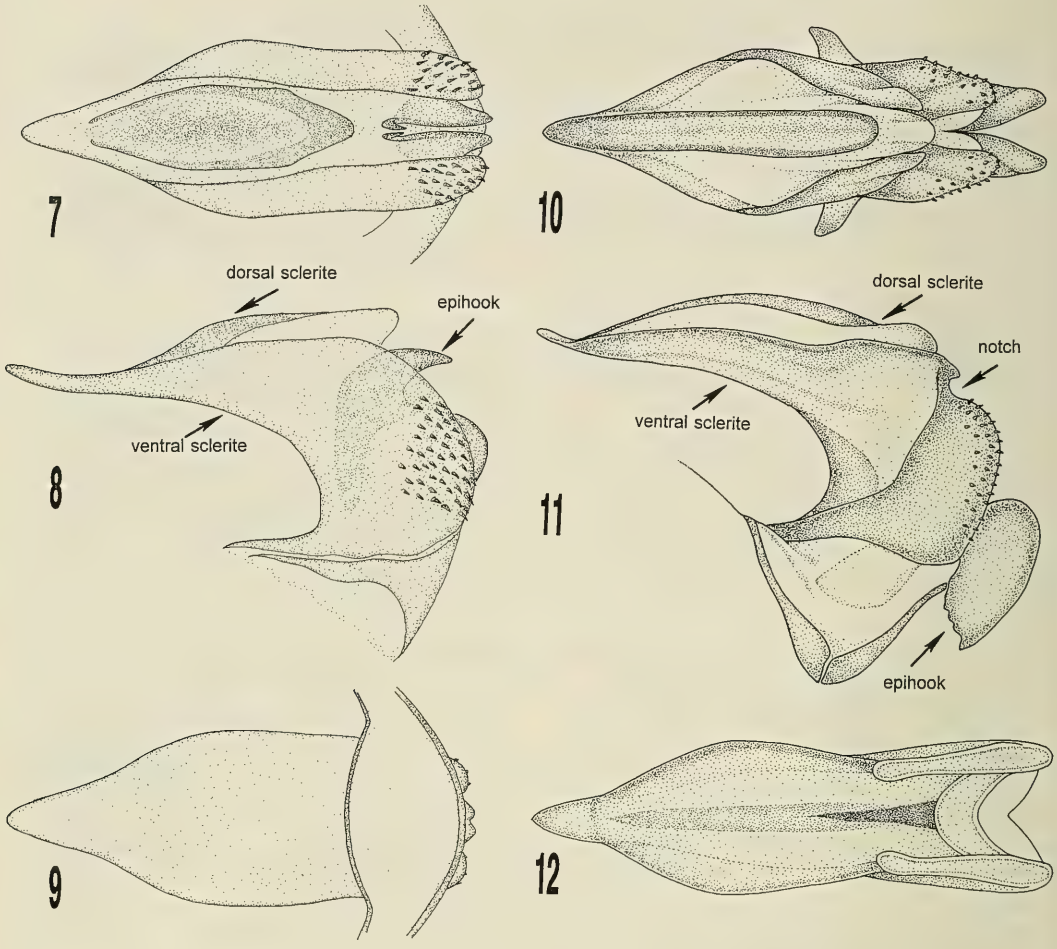
Recognition.—*Paranemoura perfecta* is very distinctive in the structure of the male epiproct. The sclerotized portion of the dorsal sclerite (epihook) is sharply pointed at the tip, where it rotates between the base of the ventral sclerite (Figs. 7, 8). In addition, the lateral basal profiles of the ventral sclerite are smoothly rounded from the base to the dorsal surface (Fig. 8). The female is difficult to separate without associated males (Fig. 13).

Distribution.—The following specimens were confirmed as part of this study based on the examination of male specimens: CANADA: NEW BRUNSWICK: Charlotte Co., tributary of Digdequash River, Hwy 127, south of Dumbarton, 15-VI-1993, R.W. Baumann and B.C. Kondratieff, 2 ♂.



Figs. 1–6. 1–3, *Paranemoura perfecta,* male terminalia. 1, Dorsal view. 2, Lateral view. 3, Ventral view. 4–6, *P. claasseni,* male terminalia. 4, Dorsal view. 5, Lateral view. 6, Ventral view.

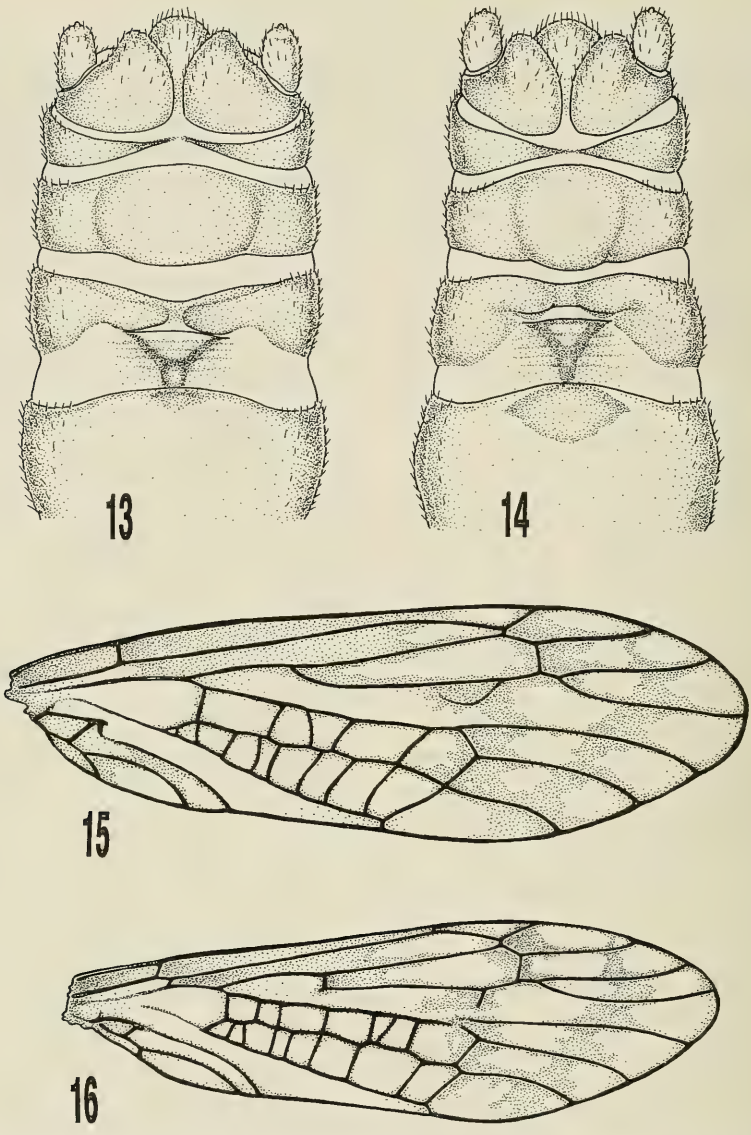
Northumberland Co., Big Eskedelloc River, Hwy 8, 17-VI-1993, R.W. Baumann and B.C. Kondratieff, 1 ♂. York Co., tributary of Magaguadavic River, Hwy 3, southeast of Thomston Corner, 14-VI-1993, R.W. Baumann and B.C. Kondratieff, 3 ♂. NOVA SCOTIA: Annapolis Co., Roop Brook, off Hwy 10, above Springfield Lake, 23-VI-1993, R.W. Baumann and B.C. Kondratieff, 3 ♂, 4 ♀. Cape Breton Co., Baddeck, Cape Breton Island, 22-VI-1936, J. McDunnough, 1 ♂, 4 ♀. Guysborough Co., Silvey Brook, Hwy 16, north of Lincolnville, 22-VI-1993, R.W. Baumann and B.C. Kondratieff, 24 ♂, 27 ♀. Kings Co., Butler Brook, below Burke Lake, Dalhouise Road, 23-VI-1993, R.W. Baumann and B.C. Kondratieff, 1 ♂. Yarmouth Co., Bear Lake Brook, Hwy 203, above Second Bear Lake, 24-VI-1993, R.W. Baumann and B.C. Kondratieff, 1 ♂, 5 ♀; Clyde River, Hwy 203, Flintstone Rock, 24-VI-1993, R.W. Baumann and B.C. Kondratieff, 1 ♂. ONTARIO: Hastings Co., 2 miles east of New Carlow, 21-IV-1968, W.E. Ricker, 1 ♂, 2 ♀. Lennox and Addington Co., 4 miles east of Vennachar, 21-IV-1968, W.E. Ricker, 1 ♂. Nipissing Co., Costello Lake, Algonquin Park, 15-V-1940, W.M. Spurles, 1 ♂. PRINCE EDWARD ISLAND: Prince Co., headwaters Grand River, Hwy 177, south of Wellington, 18-VI-1993, R.W. Baumann and B.C. Kondratieff, 2 ♂. QUEBEC:



Figs. 7–12. 7–9, *Paranemoura perfecta,* male epiproct. 7, Dorsal view. 8, Lateral view. 9, Ventral view. 10–12, *P. claasseni,* male epiproct. 10, Dorsal view. 11, Lateral view. 12, Ventral view.

Joliette Co., Mont Tremblant Park: 19-V-1954, A. Robert, 1 ♂, 5 ♀; Baie des Aulnes, 21-V-1954, 1 ♂. Témiscamingue Co., Laniel, 27-VI-1939, F.P. Ide, 1 ♂, 1 ♀. Terbonne Co., University of Montreal Biological Station: St. Hippolyte de Kilkenny, 22-V-1964, L. Venne, 1 ♂, 1 ♀; 2-V-1966, P.P. Harper, 2 ♂, 1 ♀; Lac Long, St. Hippolyte, 3-V-1966, P.P. Harper, 3 ♂, 1 ♀; 26-V-1966, 5 ♂; tributary du Lac Cromwell, St. Hippolyte, 14-V-1966, P.P. Harper, 2 ♂, 2 ♀; 10-V-1967, 24 ♂, 22 ♀. UNITED STATES: CONNECTICUT: Fairfield Co., Wolcott, 3-V-1959, S.W. Hitchcock, 1 ♂; Redding Ridge, 13-VI-1960, S.W. Hitchcock, 1 ♂; Saugatuck River, Hwy 53, Redding, 8-IV-1963, S.W. Hitchcock, 1 ♂; Aspetnek River, Easton, 5-IV-1966, S.W. Hitchcock, 1 ♂; drought stream, upper Easton, 5-IV-1966, S.W. Hitchcock, 1 ♂. Hartford Co., Staffordville, 23-IV-1964, S.W. Hitchcock, 1 ♂; Fenton River, East Willington, 5-IV-1968, S.W. Hitchcock, 2 ♂. Middlesex Co., Menunketesuck River, Killingworth, 1-IV-1965, S.W. Hitchcock, 17 ♂, 8 ♀; 5-IV-1965, 6 ♂, 17 ♀; 8-IV-1965, 1 ♂, 3 ♀; 7-IV-1969, 1 ♂. New London Co., Pachang State Forest, near Voluntown, 23-V-1966, S.W. Hitchcock, 1 ♂. MAINE: Aroostook

Co., Oxbow, on drop nets, 4-14-VI-1970, D.E. Leonard, 1 ♂, 1 ♀. Hancock Co., Mud Pond Stream, 1 mile south of Tunk Mountain, 9-VI-1982, T.M. Mingo, 2 ♂, 5 ♀; 6-VII-1982, 2 ♂, 2 ♀; Salmon Pond Stream, 1 mile south of Tunk Mountain, 7-VII-1982, T.M. Mingo, 1 ♂; Piscataquis Co., tributary Katahdin Stream, Baxter State Park, 4-V-1980, T.M. Mingo, 1 ♂; Squaw Brook, Hwy 15, below Big Squaw Mountain Ski Resort, 12-VI-1993, R.W. Baumann, B.C. Kondratieff and D.S. Potter, 1 ♂, 12 ♀. Waldo Co., seepage stream, City Point, Belfast, 25-V-1993, D.S. Potter, 1 ♂; Wing Brook, Thorndike, 13-VI-1993, R.W. Baumann, B.C. Kondratieff and D.S. Potter, 52 ♂, 29 ♀. MASSACHUSETTS: Middlesex Co., Medford, Border Road, 27-III-1954, J.F. Hanson, 7 ♂, 20 ♀; 10-IV-1956, 1 ♂, 1 ♀. MARYLAND: Allegany Co., tributary Fifteen Mile Creek, Hwy 144, 12-III-1995, S.A. Grubbs, 1 ♂; 13-IV-1996, 1 ♂. Fredrick Co., Big Hunting Creek, from trout stomach, 9-IV-1988, R.M. Duffield, 1 ♂, 1 ♀. NEW HAMPSHIRE: Grafton Co., Fox Inlet, Plymouth, 25-IV-1969, G. Wilson, 3 ♂, 1 ♀. NEW YORK: Carraraugus Co., tributary Stoddard Brook, Allegany State Park, 24-IV-1963, L.L. Pechuman, 1 ♂, 1 ♀. Essex Co., Gill Brook, tributary East Branch Ausable River, southwest of Saint Huberts, Adirondack Park, 29-IV-1991, R.W. Baumann and M.F. Whiting, 4 ♂, 7 ♀. Franklin Co., Axton, Adirondack Park, 12-22-VI-1901, A.D. McG. and C.O.H., 1 ♂, 3 ♀ (*N. punctipennis* types). Hamilton Co., Salmon River, Hwy 30, below Salmon Pond, Adirondack Park, 29-IV-1991, R.W. Baumann and M.F. Whiting, 2 ♂, 2 ♀; Hatchery Brook, Hwy 30, northwest of Speculator, Adirondack Park, 30-IV-1991, R.W. Baumann and M.F. Whiting, 1 ♂, 2 ♀. NORTH CAROLINA: Watanga Co., Blowing Rock, 23-III-1940, T.H. Frison, C.O. Mohr and A.W. Hawkins, 2 ♂. PENNSYLVANIA: Forest Co., Clarion River, Greenwood Road, 11-IV-1996, E.C. Masteller, 1 ♂. Franklin Co., Dothan Run, 25-IV-1994, J.I. Earle, 1 ♂. Huntingdon Co., Whipple Dam State Park, 22-III-1953, S.W. Frost, 1 ♂; Aughwick Creek, Runk Road, 12-IV-1996, E.C. Masteller, 1 ♂. Pike Co., 4 miles south of Hawley, Hwy 6, 19-IV-1966, L.L. Pechuman, 2 ♂. Westmoreland Co., Major Spring, Powdermill Nature Reserve, 7-IV-1993, S.A. Grubbs, 4 ♂; 28-IV-1993, 1 ♂; seep, Hwy 381, .5 miles north of Hwy 31, 7-IV-1995, S.A. Grubbs and J.I. Earle, 1 ♂. TENNESSEE: Hamilton Co., Chickamanga Creek, Hwy 27, Soddy-Daisy, 29-III-1996, C.H. and E.S. Nelson, 2 ♂. VERMONT: Bennington Co., Red Mill Brook, Hwy 9, below Red Mill Pond, 27-IV-1991, R.W. Baumann and M.F. Whiting, 2 ♂, 1 ♀; West Branch Deerfield River, Hwy 8, Heartwellville, 27-IV-1991, R.W. Baumann and M.F. Whiting, 9 ♂, 13 ♀. VIRGINIA: Bath Co., Back Creek, 1-IV-1972, G. Simmons, 1 ♂. Craig Co., Johns Creek, Hwy 658, 16-III-1980, B.C. Kondratieff, 5 ♂. Giles Co., Mountain Lake, 9-IV-1977, M. Meschter, 3 ♂, 2 ♀. Montgomery Co., Toms Creek, Hwy 655, at junction Hwy 781, 30-III-1980, B.C. Kondratieff, 5 ♂, 2 ♀. Smyth Co., tributary Grindstone Branch, Grindstone Campground, Mount Rogers Recreation Area, 13-II-1980, B.C. Kondratieff, 1 ♂. Southhampton Co., Nottoway River, Hwy 653, Carys Bridge, near Capron, 9-III-1991, R.W. Baumann and R.F. Kirchner, 1 ♂. Wythe Co., East Fork Stony Fork, Reed Creek, Hwy 717, Jefferson National Forest, 11-III-1991, R.W. Baumann and R.F. Kirchner, 1 ♂, 3 ♀. WEST VIRGINIA: Pocahontas Co., Sugar Creek, tributary Williams River, Monongahela National Forest, 3-V-1981, R.F. Kirchner, 3 ♂, 3 ♀; headwaters Sugar Creek, Hwy 76, off Hwy 151, 14-V-1990, R.W. Baumann, R.F. Kirchner and B.C. Kondratieff, 1 ♂, 7 ♀; 24-V-1994, R.F. Kirchner and B.C. Kondratieff, 27 ♂, 48 ♀; spring tributary Charles Creek, Cranberry Glades, 24-IV-1994, R.F. Kirchner and B.C. Kondratieff, 31 ♂, 5 ♀. Randolph Co.,



Figs. 13–16. 13, 14, *Paranemoura,* female terminalia. 13, *P. perfecta,* ventral view. 14, *P. claasseni,* ventral view. 15, 16, *Paranemoura* wings. 15, *P. perfecta,* right forewing. 16, *P. claasseni,* right forewing.

Marsh Fork Buckhannon River, Hwy 47, near Pickens, 24-III-1992, S.M. Clark, 1 ♂.

Paranemoura claasseni Baumann, New Species

Figs. 4–6, 10–12, 14, 16

Male: Macropterous or slightly brachypterous, wings reaching just beyond tip of abdomen; length of forewings 4.5–5.5 mm; length of body 6.0–7.0 mm. Body and legs light brown, coloration darker on head, thorax and tip of abdomen; wings brown, with darkly mottled patches along costa, and just before and just after cord, apical costal crossvein absent so typical nemourid "X" is missing, many small cubital cells present beyond arc (Fig. 16). Head broad in occipital area, eyes large, anterior margin of pronotum, where it joins head, very narrow. Anterior median margins of abdominal ter-

ga 6 and 7 as darkly sclerotized patches, terga 8 and 9 darkly sclerotized and forming narrow median bands. Hypoproct broad at base, parallel sided over ninth sternum, apex constricted abruptly to narrow nipple-like tip, which extends to base of epiproct, vesicle absent (Fig. 6). Paraprocts generally broad, inner margin with pointed projection on lateral-apical corner, outer margin formed into narrow band, which encircles base of cercus (Fig. 6). Epiproct composed mostly of large ventral sclerite, darkly sclerotized and forming boat-like keel that is broad at base and narrows down to pointed apex, dorsal aspect with sclerotized area in anterior ⅓, ventral portion rounded, naked of spines and darkly sclerotized, base with irregularly rounded margin that is notched near dorsal lateral surface, patch of small spines present below notch; dorsal sclerite small but darkly sclerotized, with sharp anterior projection and more blunt posterior projection that has jagged, teeth-like structures at apex, forming rounded process (epihook), that rotates in and out of ventral sclerite; basal sclerites large, darkly sclerotized and triangle shaped (Figs. 4, 5).

Female: Macropterous to slightly brachypterous. Length of forewings 5.5–6.5 mm; length of body 6.0–7.0 mm. Body, appendages and wings similar to male. Subgenital plate mostly lightly sclerotized medially, with darkly colored, Y-shaped pattern over vaginal opening, posterior-lateral margins more darkly sclerotized. Pregenital plate large and broadly rounded posteriorly, only lightly sclerotized except for darker round patch medially near base of "Y" on segment eight (Fig. 14).

Diagnosis: *Paranemoura claasseni* is most distinctive in the shape of the male epiproct. In dorsal view, the epiproct is more expanded medially in *P. claasseni* (Figs. 4, 10) than in *P. perfecta* (Figs. 1, 7). The lateral margin of the ventral sclerite is notched in *P. claasseni* (Fig. 11), where it is smoothly rounded in *P. perfecta* (Fig. 8). Additionally, the epihook of the dorsal sclerite is bluntly pointed with jagged teeth where it extends outward in *P. claasseni* (Fig. 11), while in *P. perfecta* it is smooth and sharply pointed (Fig. 8). The females are difficult to separate without associated males.

Type material: Holotype ♂, allotype ♀ and 119 ♂ and 6 ♀ paratypes from Maine, Kennebec County, Crystal Spring, Rome, 31-V-1987, R.W. Baumann and G.Z. Jacobi. Holotype deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC. Additional paratypes were examined from the following localities: CANADA: NEW BRUNSWICK: Carleton Co., Gibson Creek, Hwy 105, Northhampton, 15-VI-1993, R.W. Baumann and B.C. Kondratieff, 2 ♂, 5 ♀. Charlotte Co., tributary Digdequash River, Hwy 127, south of Dumbarton, 15-VI-1993, R.W. Baumann and B.C. Kondratieff, 42 ♂, 24 ♀. Gloucester Co., Nepisiguit River, Hwy 360, north of Bathhurst Mines, 17-VI-1993, R.W. Baumann and B.C. Kondratieff, 2 ♂. Northumberland Co., Barnaby River, Hwy 126, southeast of Barnaby River, 17-VI-1993, R.W. Baumann and B.C. Kondratieff, 12 ♂, 1 ♀. Restigouche Co., Williams Brook, off Hwy 180, north of Mount Carleton Provincial Park, 16-VI-1993, R.W. Baumann and B.C. Kondratieff, 28 ♂, 8 ♀. York Co., tributary of Magaguadavic River, Hwy 3, southeast of Thomston Corner, 14-VI-1993, R.W. Baumann and B.C. Kondratieff, 16 ♂, 33 ♀; Pokiok Stream, Hwy 635, below Lake George, 15-VI-1993, R.W. Baumann and B.C. Kondratieff, 24 ♂, 78 ♀. NOVA SCOTIA: Colchester Co., boggy stream, Hwy 104, 3 km east of Masstown, 22-VI-1993, R.W. Baumann and B.C. Kondratieff, 1 ♂. Halifax Co., Cooks Brook, Hwy 224, Cooks Brook, 23-VI-1993, R.W. Baumann and B.C. Kondratieff, 46 ♂, 29 ♀; Gays River, junction Hwys 277 and 224, Carrolls Corner, 23-VI-1993, R.W. Baumann and B.C. Kondratieff, 1 ♂, 4 ♀. PRINCE EDWARD ISLAND: Prince Co., headwaters Grand River, Hwy 177, south of Wellington, 18-VI-1993, R.W. Baumann and B.C. Kondratieff, 6 ♂, 4 ♀. QUEBEC: Saguenay

Co., Matamek River, 30 km east of Sept-Iles, VI-1975, N.E. Williams, 1 ♂, 2 ♀. UNITED STATES: MAINE: Waldo Co., Halfmoon Stream, Hwy 220, Thorndike, 13-IV-1993, R.W. Baumann, B.C. Kondratieff and D.S. Potter, 3 ♂, 1 ♀. Washington Co., Narraguagus River, Hwy 9, 5-V-1973, T.M. Mingo, 1 ♂, 2 ♀; Tomah Stream, Hwy 6, southwest of Vanceboro, 4-V-1982, T.M. Mingo, 1 ♂, 1 ♀; 30-V-1982, 3 ♂; southeast of Topsfield, 14-VI-1993, R.W. Baumann and B.C. Kondratieff, 76 ♂, 80 ♀. NEW HAMPSHIRE: Coos Co., Pittsburg, 22-VI-1954, R.L. Blickle, 4 ♂, 6 ♀.

Additional *Paranemoura* records.—Since it is not possible to make specific determinations without male adults, a number of localities were not included under either of the named species. This problem is especially apparent in the more northern areas of Canada and the United States, where it is possible to find both *Paranemoura* species at the same site. The southern records probably all refer to *P. perfecta* but where the dividing line occurs in New England is not known. Thus the following distribution records are included, where only female specimens have been collected. CANADA: NEW BRUNSWICK: Queens Co., Gagetown, 6-VI-1933, C.E. Atwood, 2 ♀; Number Ten Brook, Hwy 101, Clarendon, 25-VI-1993, R.W. Baumann and B.C. Kondratieff, 1 ♀. Northumberland Co., Halcomb, 8-VII-1951, E.E. Gilbert, 4 ♀. Sunbury Co., Oromocto River, Hwy 101, Tracy, 25-VI-1993, R.W. Baumann and B.C. Kondratieff, 3 ♀. NOVA SCOTIA: Hants Co., Herbert River, Hwy 14, 23-VI-1993, R.W. Baumann and B.C. Kondratieff, 2 ♀. Queens Co., boggy stream, Hwy 210, above Beavertail Basin, 24-VI-1993, R.W. Baumann and B.C. Kondratieff, 8 ♀. ONTARIO: Frontenac Co., 2 miles from Snow Road, 21-IV-1968, W.E. Ricker, 2 ♀. Nipissing Co., Cache Lake, Algonquin Park, 4-VI-1936, W.M. Sprules, 1 ♀; Head Lake, Algonquin Park, 9-VI-1936, W.M. Sprules, 1 ♀. Renfrew Co., Meridian Road, Forest Station, Petawawa, 28-V-1959, J.R. Vockeroth, 1 ♀. PRINCE EDWARD ISLAND: Kings Co., Morell River, Hwy 320, Riverton, 20-VI-1993, R.W. Baumann and B.C. Kondratieff, 1 ♀. QUEBEC: Chicoutimi Co., Pikauba River, Laurentides Park, 21-VII-1938, V.D. Vladykov, 1 ♀. Gatineau Co., Fortune Creek, ridge road, Gatineau Park, 31-V-1964, W.E. Ricker, 1 ♀. Joliette Co., Mont Tremblant Park: Ruisseau Beattie, 11-VI-1957, A. Robert, 2 ♀; Ruisseau des Erables, 19-VI-1959, A. Robert, 1 ♀; 30-VI-1961, 1 ♀. Témiscamingue Co., Temiskaming, 22-VII-1939, F.P. Ide, 1 ♀. UNITED STATES: CONNECTICUT: Tolland Co., Storrs, 4-V-1959, Camp, 1 ♀; 12-V-1959, Rizzo, 1 ♀. MAINE: Aroostock Co., Madawaska Lake, Stockholm, 17-VI-1953, J.F. Hanson, 2 ♀; 8-VII-1953, 1 ♀; Masardis, 13-VII-1960, A.E. Brower, 1 ♀. Franklin Co., Rangeley, 19-VI-1960, 1 ♀. Hancock Co., Lake Wood, Mount Desert Island, 13-VI-1953, M.E. Smith, 1 ♀. Oxford Co., Newton Brook, Hwy 2, Newton Brook Rest Area, 31-V-1987, R.W. Baumann and J.Z. Jacobi, 2 ♀. Penobscot Co., Pushaw Stream, Hwy 43, Hirundo Wildlife Sanctuary, 9-VI-1982, T.M. Mingo, 4 ♀. Piscataquis Co., Bennett Brook, Hwy CC, 5 miles west of Hwy 15, 11-VI-1993, R.W. Baumann, B.C. Kondratieff and D.S. Potter, 2 ♀. Somerset Co., East Branch Sandy Stream, Hwy 101, north of Denniston, R.W. Baumann, B.C. Kondratieff and D.S. Potter, 7 ♀; headwaters South Fork Penobscot River, Hwy 210, 12-VI-1993, R.W. Baumann, B.C. Kondratieff and D.S. Potter, 5 ♀; Trout Brook, Hwy 15, above Long Lake, 12-VI-1993, R.W. Baumann, B.C. Kondratieff and D.S. Potter, 11 ♀. Waldo Co., Webb Brook, Webb Road, Thorndike, 5-VI-1993, D.S. Potter, 2 ♀. MASSACHUSETTS: Berkshire Co., brooklet 1 mile north of Hwy 20, October Mountain State Forest, 27-IV-1991, R.W. Baumann and M.F. Whiting, 2 ♀. NEW HAMPSHIRE: Grafton Co., Dorchester, 13-VI-1964, S.W. Hitchcock, 1 ♀. NEW JERSEY: Gloucester Co., Iona, 21-IV-1907, ?, 1 ♀. Sussex Co., Little Flat Brook, Hwy 650, southeast of Milford, 5-V-1991, R.W. Baumann and

S.A. Wells, 1 ♀. NEW YORK: Franklin Co., Halfway Brook, Hwy 3, between Middle and Lower Saranac Lakes, Adirondack Park, 29-IV-1991, R.W. Baumann and M.F. Whiting, 2 ♀. Hamilton Co., Dog Creek, tributary Sacandaga River, Hwy 30, 5 miles south of Lake Algonquin, Adirondack Park, 30-IV-1991, R.W. Baumann and M.F. Whiting, 1 ♀; Grampus Brook, Hwy 30, below Grampus Lake, Adirondack Park, 29-IV-1991, R.W. Baumann and M.F. Whiting, 1 ♀. Herkimer Co., Old Forg, 26-VI-1905, ?, 1 ♀. VIRGINIA: Bath Co., tributary Wilson Creek, Hwy 629, 1 mile south of Douthat State Park, 12-V-1979, C.R. Parker, 1 ♀. Botetourt Co., Buchanan, 22-IV-1974, R.L. Hoffman, 2 ♀. Tazewell Co., East Fork Cove Creek, Hwy 662, 1.5 miles north of Cove Creek, 16-V-1994, R.W. Baumann, R.F. Kirchner and B.C. Kondratieff, 4 ♀. WEST VIRGINIA: Pendleton Co., headwaters Seneca Creek, Judy Springs Trail, 15-V-1990, R.W. Baumann, R.F. Kirchner, B.C. Kondratieff and J.L. Welch, 10 ♀. Raleigh Co., Cherry Creek, tributary of Beaver Creek, 1 mile south of Cherry Creek, 1-V-1987, B.C. Kondratieff, 7 ♀; tributary Little Beaver Lake, Little Beaver State Park, 25-V-1990, R.W. Baumann and S.M. Clark.

Discussion.—*Paranemoura* has been considered a monotypic genus for thirty years. Specimens are rarely collected by most field workers, so adequate material has not been available until recently. However, intensive collecting in the correct habitats, using a beating sheet or searching on tree trunks near streams, has proven to be quite effective. Since adult males are needed for specific determination and since both species often occur in the same stream, it is useful to collect a large series of adults.

Paranemoura perfecta is widely distributed from the Great Smoky Mountains in the South to the Canadian Maritime Provinces in the North. In contrast *P. claasseni* appears to be restricted to the extreme eastern provinces of Canada and the northern New England States in the United States.

Acknowledgments

The help of the following institutions and individuals, who made their *Paranemoura* specimens available, is greatly appreciated: Stephen Brooks and Peter Ward, the Museum of Natural History (TMNH); Shawn Clark, West Virginia Department of Agriculture; Richard Duffield, Howard University; Jane Earle, Mount Holly Springs, Pennsylvania; Oliver S. Flint, Jr. and Nancy Adams, Smithsonian Institution; Scott Grubbs, University of Pittsburg; Peter Harper, University of Montreal; Stephen Hitchcock, Haddam, Connecticut; Richard Hoebeke, Cornell University (CUIC); Noel Hynes, Waterloo, Ontario; Fred Kirchner, Huntington, West Virginia; Boris Kondratieff, Colorado State University; Jack Martin and Raymond Hutchinson, Canadian National Collection; Ed Masteller, Pennsylvania State University Behrend Campus; Terry Mingo, University of Maine; Charles Nelson, University of Tennessee, Chattanooga; Philip Perkins and David Furth, Museum of Comparative Zoology; David Potter, Unity College; William Ricker, Nanaimo, British Columbia; Donald Webb and Kathy Methven, Illinois Natural History Survey; Reese Voshell, Virginia Polytechnic Institute and State University. In addition, I recognize the following individuals that collected with me in eastern North America, when *Paranemoura* specimens were obtained: Shawn Clark, Gerald Jacobi, Fred Kirchner, Boris Kondratieff, David Potter, Michael Whiting, and Sam Wells. The illustrations were made by Jean Stanger-Leavitt and Debra Horner.

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98(4), 1996, pp. 827–828

NOTE

Torymidae (Hymenoptera) new to Washington State

Located in south-central Washington State, the 560 square mile Hanford Site has been closed to the general public since 1943. Originally acquired by the United States federal government as a site for the production of plutonium for weapons production, Hanford is currently administered by the Department of Energy for nuclear waste management, environmental restoration, and research and development.

During the period 1994–95, a biodiversity analysis of insects was conducted at the Hanford Site, primarily on the Fitzner-Eberhardt Arid Lands Ecology Reserve (ALE). The ALE, located in Benton County (latitude 46°N, longitude 119°W), occupies just over 100 square miles in the south-western portion of the Hanford Site. The ALE was established in 1967 to preserve "portions of vegetation types that once covered a great expanse of the West" (O'Farrell. 1973. Pacific Search (July): 3–8). The vegetation type referred to by O'Farrell is primarily the shrub-steppe system, a pre-European settlement vegetation consisting mainly of shrubs, perennial bunchgrasses, and a variety of forbs. Typical shrubs include several species of sagebrush [*Artemisia* spp.], rabbitbrush [*Chrysothamnus* spp.], and bitterbrush [*Purshia* spp.]. Grasses include bluebunch wheatgrass [*Agropyron spicatum* (Pursh) Scribn. & Smith], Idaho fescue [*Festuca idahoensis* Elmer], needle-and-threadgrass [*Stipa* spp.], and Sandburg's bluegrass [*Poa sandbergii* Vasey]. Some of the more commonly encountered perennial forbs include species of lupine [*Lupinus* spp.], desert parsley [*Lomatium* spp.], buckwheat [*Eriogonum* spp.], balsamroot [*Balsamorhiza* spp.], and milkvetch [*Astragalus* spp.].

During the two-year study, over 30,000 insect specimens were collected, prepared for identification, and sorted to ordinal level by Richard Zack. This note documents the first Washington State records for 8 species of the parasitic wasp family Torymidae, increasing the number of torymids reported from 14 species to 22 (Grissell 1976. University of California Publications in Entomology 79: 1–120; 1979. Catalog of Hymenoptera in America North of Mexico Vol. 2: 748–768; 1995. Memoirs on Entomology, International 2: 1–470). Currently 176 species of Torymidae are known in America north of Mexico. Most of the new-found species are widespread in the western states but have not been recorded previously for the state of Washington. Additionally, in this note, we provide new distribution records for 5 species known to occur in the state, and the remaining 9 reported species are listed. All specimens were collected by sweeping vegetation and are housed at the James Entomological Collection, Washington State University. Specific locations for individual specimens within ALE are available from Richard Zack. Unless noted in the list below, data for *Torymus* is from Grissell 1976 and for other taxa from Grissell 1979 and 1995.

First-documented records for species from Washington State (taxa preceded by an asterisk (*) are first report of genus):

**Diomorus zabriskii* Cresson: widespread throughout the United States and known from British Colombia. This species is associated with nests of Sphecidae (*Extemnius, Crossocerus, Rhopalum*) and Anthophoridae (*Ceratina*).

Monodontomerus viridiscapus Gahan: widespread from southern British Columbia to Mexico. This species is associated with several genera of Lepidoptera (*Orgyia, Malacosoma, Eucheira*) and their ichneumonid parasites (*Gambrus, Phytodietus, Scambus*).

**Pseuderimerus mayetiolae* Gahan: known only from California. This species is associated with the Hessian fly (*Mayetiola destructor* (Say).

**Pseudotorymus lazulellus* (Ashmead): widespread but spotty distribution from eastern United States and southern Canada as far west as Colorado. This species is associated with eurytomid gall-formers (*Tetramesa*) in grass stems, cecidomyiid gall-formers (*Dasyneura*) on composites, and unknown hosts in flower heads of *Trifolium.*

Torymus aeneoscapus (Huber): widespread in the Western United States (Arizona, California, Idaho, Montana, Nevada, Oregon, Utah, and Wyoming). This species is associated with cecidomyiid galls (*Diarthromyia, Rhopalomyia*) on *Artemisia, Chrysothamnus,* and *Salvia.*

Torymus capillaceus albitarsis (Huber): widespread in the western United States (eastern Texas; northern areas of New Mexico, Arizona, and California; and Kansas, Colorado, Utah, Nevada, and Idaho). This subspecies is associated with cecidomyiid galls (*Asphondylia, Lasioptera*) on *Chrysothamnus, Helianthus, Aster, Ratibida, Ambrosia,* and *Mimosa.*

Torymus kinseyi (Huber): widespread in the Western United States (California, Idaho, Montana, Nevada, and Utah). This species is associated with tephritid (*Trypeta*) galls on *Chrysothamnus,* cecidomyiid (*Diarthomyia*) galls on *Artemisia,* and unknown cecidomyiid galls on *Chrysothamnus* and *Erigeron.*

**Zaglyptonotus schwarzi* Crawford: widespread from eastern United States to Idaho. This species is reared from Lepidoptera (*Isophrictis*) in sunflower (*Helianthus*) heads and may attack weevils (*Desmoris*) in the same plant; it has also been reared from tephritid seed maggots in flower heads of *Vernonia.*

The following taxa, previously reported for Washington State, were also collected on the Hanford Site:

Microdontomerus anthonomi (Crawford): widespread throughout the western United States. This species is associated with weevils, bruchids, tephritids and their braconid parasites in composite flower and seed heads (Turner et al. 1990: Pan-Pacific Entomologist 66: 162–166).

Monodontomerus montivagus Ashmead: widespread throughout southern Canada and the United States south into Mexico. It is associated with many solitary bees and some wasps (e.g. eumenines).

Torymus coloradensis (Huber): widespread in the western United States, but previously known in Washington from only one location in Whitman County. This species is associated with cecidomyiid galls on *Artemisia.*

Torymus koebelei (Huber): widespread in the western United States and upper Mexico but previously known in Washington from only one location in Klickitat County. It is associated with cecidomyiid galls on *Baccharis, Artemisia, Erigeron,* and *Chrysothamnus.*

Torymus thalassinus (Crosby): widespread in the western United States but previously known in Washington from only two locations in Franklin County. This species has been reared from the stems of grass species in 6 genera and is probably a parasite of *Tetramesa* (Eurytomidae), a gall former in grass stems.

The following 9 species have previously been reported from Washington State (Grissell 1976, 1979): *Torymus bedeguaris* (Linnaeus), *T. bicoloratus* (Huber), *T. cecidomyiae* (Walker), *T. chrysochlorus* (Osten Sacken), *T. citripes* (Huber), *T. fagopirum* (Provancher), *T. longistigmus* (Huber), *T. solitarius* (Osten Sacken), and *Monodontomerus aeneus* (Fonscolombe).

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MEMBERSHIP LIST OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

The previous list was published in July 1993 with 473 members; the present list contains 401 members from every state in the union except Alaska, Maine, Massachusetts, Nevada, and Oregon. The largest representation is in Maryland (63), followed by the District of Columbia (39), California (30), Florida (24), and Virginia (15). The figures from the Washington, D.C. area are slightly skewed since some members receive their Proceedings at office addresses. Five of the Canadian provinces are represented and eighteen other countries, on five continents, are represented.

The format used in this list essentially follows that of the 1993 list. Names of Honorary Members are capitalized, those of Emeritus Members are italicized, and Life Members are distinguished by an Asterisk (32) following the date they joined the Society. Dates of election to Honorary or Emeritus status are entered in parentheses. In 1988, Dr. Curtis W. Sabrosky was elected to Honorary President, and Dr. Louise M. Russell and Dr. Alan Stone were elected to Honorary membership. In 1993, Dr. Karl V. Krombein was elected to Honorary membership.

I thank Dianne Mathis for her assistance in the preparation of this list. Any corrections to the list can be sent to the Corresponding Secretary at the address on the inside front cover of this issue. Corrections will be read at the next meeting of the Society, and will be published in the Proceedings by the Recording Secretary.

Holly B. Williams,
Corresponding Secretary

Abe, Masaki 1988 JAPAN
Adams, J. R. 1963 Maryland
Adams, M. S. 1983 New York
Adamski, D. 1984 District of Columbia
Adler, P. H. 1986 South Carolina
Ahlstrom, K. R. 1992 North Carolina
Aitken, T. G. H. 1957 (1984) Connecticut
Aldrich, J. R. 1994 Maryland
Anderson, D. M. 1954 Maryland
Anderson, L. D. 1944 (1989) California
Apsey, R. P. 1992 Michigan
Armitage, B. J. 1983 Ohio
Arnaud, P. H., Jr. 1955 California

Babin, M. J. 1992 Louisiana
Baker, G. T. 1987 Mississippi
Baker, R. H. 1992 Florida
Ball, G. E. 1948 Alberta
Balogh, G. J. 1994 Michigan
Barber, K. N. 1985 Ontario
Barnes, J. K. 1978 New York
Barros, C. de Carvalho 1995 BRAZIL
Barrows, E. M. 1976 District of Columbia
Baumann, R. W. 1972 Utah
Baumgardner, D. 1992 Maryland
Becker, V. O. 1987* BRAZIL
Bell, R. T. 1955 Vermont
Bellinger, R. G. 1972 South Carolina
Berry, R. L. 1972 Ohio
Bezark, L. G. 1974 California
Bicha, W. 1981 Tennessee
Bickley, W. E. 1949* Maryland
Bilby, P. J. 1993 New Jersey
Blom, P. E. 1986 Idaho
Boettcher, R. A. 1955 District of Columbia
Bohart, R. M. 1944 California
Boldt, P. E. 1987 Texas
Borkent, A. 1988 British Columbia
Bowles, D. E. 1993 Texas
Brailovsky, H. 1996 MEXICO
Broda-Hydom, S. 1991 Maryland
Brodel, C. F. 1991 Florida
Brou, V. A. 1985 Louisiana

Brown, B. V. 1993 California
Brown, H. P. 1977 Oklahoma
Brown, R. L. 1979 Mississippi
Bruce, W. A. 1995 Maryland
Brushwein, J. R. 1987 Florida
Bueno-Soria, J. 1977 MEXICO
Burger, J. F. 1972 New Hampshire
Burke, H. R. 1981 Texas
Burns, J. M. 1975* District of Columbia
Burrows, W. L. 1983 West Virginia
Butler, L. 1966 West Virginia
Byers, G. W. 1984 Kansas

Carlson, R. W. 1970* Maryland
Carmen-Coscarón, M. del 1996 ARGENTINA
Carroll, J. F. 1977 Maryland
Cave, R. D. 1977 HONDURAS
Chapin, J. B. 1973 Louisiana
Clark, W. E. 1975 Alabama
Connor, E. F. 1990 Virginia
Contreras-Ramos, A. 1986 Minnesota
Cook, J. L. 1996 Texas
Cooper, K. W. 1955 California
Coovert, G.A. 1996 Ohio
Coulson, J. R. 1961 Maryland
Couri, M. S. 1988 BRAZIL
Courneya, P. 1986 Florida
Courtney, G. W. 1985 Michigan
Covell, C. V., Jr. 1971 Kentucky
Cross, H. F. 1954 Georgia

Darling, D. C. 1981 Ontario
Darsie, R. F. 1949 South Carolina
Davis, D. R. 1961 District of Columbia
Davis, L. R. 1992 Florida
Deeming, J. C. 1974* WALES
Deitz, L. L. 1982 North Carolina
Dennis, S. 1976 Colorado
Dewalt, R. E. 1992 Illinois
Deyrup, M. A. 1979 Florida
Donnelly, T. W. 1962 New York
Dozier, H. L. 1952* South Carolina
Drummond, R. O. 1954 (1987) Texas
Duffield, R. M. 1996 District of Columbia

Eckerlin, R. P. 1990 Virginia
Enns, W. R. 1960 Missouri
Epstein, M.E. 1994 District of Columbia
Erwin, T. L. 1972 District of Columbia
Evans, H. E. 1948 Colorado
Evans, W. G. 1957 (1994) Alberta
Evenhuis, N. L. 1980 Hawaii

Fales, J. H. 1944 Maryland
Fee, F. D. 1983 Pennsylvania
Feller, C. 1989 Maryland
Ferguson, D. C. 1969 District of Columbia
Fernandez, G. W. 1991 BRAZIL
Firko, M. J. 1994 Maryland
Fisher, E. M. 1977 California
Fisk F. W. 1968 (1988) Florida
Fitzgerald, S. 1996 Colorado
Flint, O. S., Jr. 1961 District of Columbia
Flowers, R. W. 1994 Florida
Floyd, M. A. 1991 Kentucky
Fluno, J. A. 1957 Florida
Foote, B. A. 1958 Ohio
Foote, R. H. 1950 Virginia
Forattini, O. P. 1956 BRAZIL
Fox, I. 1936 Puerto Rico
Franclemont, J. G. 1947 New York
Frank, J. H. 1994 Florida
Freidberg, A. 1979 ISRAEL
Freytag, P. H. 1979 Kentucky
Furth, D. G. 1994 District of Columbia

Gagné, R. J. 1966* District of Columbia
Gaimari, S. D. 1995 Illinois
Gelhaus, J. K. 1989 Pennsylvania
Gentry, J. W. 1958 Florida
Gibson, L. P. 1981 Ohio
Gimpel, W. F., Jr. 1995 Maryland
Glaser, J. D. 1988 Maryland
Goeden, R. D. 1982 California
Gomez-Arias, L. M. 1992 Florida
Gordon, R. D. 1968 North Dakota
Gorham, J. R. 1974 (1995) District of Columbia
Grace, J. K. 1987 Hawaii
Grissell, E. E. 1979 District of Columbia

Habeck, D. H. 1957 Florida
Hagen, K. S. 1949 California
Haines, K. A. 1952 Virginia
Halbert, S. E. 1989 Florida
Hamilton, S. W. 1982 Tennessee
Hanks, L. M. 1993 California

Hanley, R. S. 1994 Kansas
Hanson, P. 1985 COSTA RICA
Hansson, C. 1985 SWEDEN
Harbach, R. E. 1990 GREAT BRITAIN
Harlan, H. J. 1988 Maryland
Harman, D. M. 1966 Maryland
Harrington, D. 1989 Texas
Harris, S. C. 1979 Pennsylvania
Harrison, B. A. 1976 North Carolina
Harrison, T. L. 1993 Illinois
Headrick, D. H. 1992 California
Henry, T. J. 1975 District of Columbia
Heppner, J. B. 1974 Florida
Heraty, J. M. 1986 California
Hernandez, M. S. V. 1992 MEXICO
Hespenheide, H. A., III 1981 California
Hevel, G. F. 1970 District of Columbia
Heydon, S. L. 1986 California
Hight, S. 1990 Maryland
Hilton, D. F. J. 1990* Quebec
Hodges, R. W. 1960* District of Columbia
Hoebeke, E. R. 1980 New York
Hoffmann, C. H. 1945 Maryland
Hoffman, K. M. 1986 South Carolina
Holzbach, J. E. 1984 Ohio
Hopla, C. E. 1961 Oklahoma
Howden, H. F. 1948 Ontario
Huang, Y. M. 1968 District of Columbia
Hung, A. C. F. 1981 Maryland
Hurd, L. E. 1988 Virginia
Husband, R. W. 1972 Michigan

Imai, E. M. 1983 Maryland
Irwin, M. E. 1976 Illinois
Ivie, M. A. 1984 Montana

Jimenez, H. H. 1994 MEXICO
Johnson, E. L. 1995 Washington
Johnson, J. B. 1987 Idaho
Johnson, N. F. 1980 Ohio
Johnson, P. J. 1984 South Dakota
Joseph, S. R. 1957 Maryland
Judd, D. 1994 District of Columbia

Kaster, C. H. 1979 Michigan
Keffer, S. L. 1993 Virginia
Keirans, J. E. 1984 Georgia
Kennedy, J. H. 1995 Texas
Kethley, J. B. 1974 Illinois
Kim, K. C. 1983 Pennsylvania
Kimsey, L. S. 1994 California
Kingsolver, J. 1963 (1992) Florida
Kirchner, R. F. 1981 West Virginia
Kitayama, C. 1974 California
Kittle, P.D. 1975 Alabama
Knipling, E. E. 1946 (1985) Maryland
Knutson, L. V. 1963* FRANCE
Kondratieff, B. C. 1992 Colorado
Korch, P. P. 1993 Pennsylvania
Kosztarab, M. 1978 (1994) Virginia
KROMBEIN, K. V. 1941* (1993) District of Columbia
Krysan, J. L. 1993 Maryland
Kuenen, L. P. 1995 Maryland

Labandeira, C. C. 1993 District of Columbia
Lago, P. K. 1984* Mississippi
Lakin, K. R. 1994 Maryland
La Vigne, R. 1973 Wyoming
Lee, C. E. 1989 SOUTH KOREA
Levesque, C. 1985 Quebec
Lewis, J. A. 1994 District of Columbia
Lewis, P. A. 1974 Ohio
Lewis, R. E. 1958 Iowa
Lien, J. C. 1967 TAIWAN REPUBLIC OF CHINA
Lisowski, E. A. 1988 Washington
Little, R. G. 1993 California
Loechelt, H. K. 1988 Washington
Loeffler, C. C. 1992 Pennsylvania
Lozada, P. 1991 PERU
Lyon, R. J. 1961 California

MacDonald, J. F. 1984 Indiana
MacKay, W. P. 1982 Texas
Magner, J. M. 1953 Missouri
Maier, C. T. 1976 Connecticut
Main, A. J., Jr. 1965 New York
Manglitz, G. R. 1956 (1989) Nebraska
Manley, D. G. 1984 South Carolina
Marshall, S. 1982 Ontario
Mason, H. C. 1949 (1973) Maryland
Masteller, E. C. 1995 Pennsylvania
Mathis, W. N. 1976* District of Columbia
May, E. 1990 Kansas
McCabe, T. L. 1977 New York
McComb, C. W. 1956 Virginia

McDonald, F. J. D. 1983 AUSTRALIA
McGovran, E. R. 1937 (1973) Maryland
McGuire, J. U., Jr. 1954 (1987) Puerto Rico
McKamey, S. H. 1989 Connecticut
McKeever, S. 1990 Georgia
McPherson, J. E. 1985 Illinois
Mead, F. W. 1976 (1995) Florida
Mejdalani, G. 1996 BRAZIL
Menke, A. S. 1969 District of Columbia
Michener, C. D. 1994. Kansas
Miller, D. R. 1972 Maryland
Miller, G. L. 1981 Maryland
Miller, L. R. 1984 West Virginia
Miller, R. S. 1981 Montana
Miller, S. E. 1980* Hawaii
Miller, T. D. 1988 Idaho
Mitchell, R. T. 1949 (1978) Maryland
Moore, T. E. 1950 Michigan
Moran, M. D. 1994 Delaware
Morse, J. C. 1976 South Carolina
Moulton, J. K. 1994 Arizona
Moulton, S. R., II 1988 Colorado
Muñoz-Quesada, F. 1996 Minnesota
Munroe, E. 1986 Ontario
Munson, S. C. 1938 (1975) District of Columbia

Nakahara, S. 1968 Maryland
Neal, J. W., Jr. 1982* Maryland
Neff, S. E. 1969 Pennsylvania
Nelson, C. H. 1969 Tennessee
Nelson, G. H. 1949 California
Neunzig, H. H. 1956 North Carolina
Norrborn, A. L. 1989 District of Columbia
Nuhn, T. P. 1981 Virginia

Oatman, E. R. 1980 California
O'Brien, M. F. 1979 Michigan
Olsen, A. R. 1989 California
Orr, R. L. 1990 Maryland
Osbrink, W. L. A. 1984 Wisconsin
Oswald, J. D. 1987 Texas

Packauskas, R. J. 1993 Kansas
Pagac, B. P., Jr. 1984 Maryland
Painter, H. F. 1990 Virginia
Pakaluk, J. 1992* Maryland
Parker, C. R. 1977 Tennessee
Parrish, D. W. 1963 (1987) Maryland
Parsons, M. A. 1963 Ohio
Patterson, J. L. 1991 Maryland
Peterson, R. V. 1952 Utah
Pike, K. 1995 Washington
Pinto, J. D. 1982 California
Plakidas, J. D. 1986 Maryland
Pogue, M. 1996 Maryland
Polhemus, D. A. 1993 District of Columbia
Polhemus, J. T. 1964 Colorado
Porter, C. H. 1984 Georgia
Pratt, H. D. 1943 Georgia
Price, R. D. 1963 Arkansas
Pulawski, W. J. 1975 California

Quintero Arias, D. 1990 Florida

Rack, G. 1975 GERMANY
Rainwater, C. F. 1954 (1975) Maryland
Rainwater, H. I. 1964 (1983) Maryland
Ramsay, M. J. 1968 Maryland
Rawlins, J. F. 1974 Pennsylvania
Reichart, C. V. 1946 Rhode Island
Ribeiro-Costa, C. S. 1992 BRAZIL
Richards, A. B. 1996 Colorado
Richardson, H. H. 1939 (1976) New Jersey
Rider, D. A. 1991 North Dakota
Riegel, G. T. 1952 Illinois
Riley, D. R. 1984 Texas
Robbins, R. G. 1979* Maryland
Robbins, R. K. 1986 District of Columbia
Robbins, T. O. 1989 Texas
Robinson, H. E. 1963 District of Columbia
Root, R. B. 1984 New York
Rothschild, M. J. 1989 Maryland
Roughley, R. E. 1992 Manitoba
Rozen, J. G., Jr. 1956 New York
Ruiter, D. 1976 Colorado
Rumph, J. A. 1996 Washington
RUSSELL, L. M. 1930 (1988) Maryland

SABROSKY, C. W. 1946 (1988) New Jersey
Sands, D. P. A. 1984 AUSTRALIA
Santana, F. J. 1966 Florida
Saugstad, E. S. 1979 Maryland
Scarbrough, A. G. 1971 Maryland
Schaefer, C. W. 1985 Connecticut
Schauff, M. E. 1980 District of Columbia

Schick, K. 1994 California
Schiff, N. M. 1991* California
Schmidt, C. H. 1969 North Dakota
Schmude, K. L. 1990 Wisconsin
Scudder, G. G. E. 1984 British Columbia
Sedlacek, J. D. 1988 Kentucky
Shaffer, J. C. 1974 Virginia
Shands, W. A. 1940 (1991) South Carolina
Sharkov, A. 1995 Ohio
Shaw, S. R. 1991 Wyoming
Shepard, W. D. 1992 California
Sheppard, W. S. 1995 Maryland
Shinohara, A. 1981 JAPAN
Shorthouse, J. D. 1986 Ontario
Sites, R. W. 1989 Missouri
Skelley, P. E. 1992 Florida
Slater, J. A. 1949 Connecticut
Slater, J. A., II 1992 Kansas
Sleeper, E. L. 1976 California
Sloan, M. J. 1983 (1990) District of Columbia
Smiley, R. L. 1964 Maryland
Smith, C. F. 1967 (1987) North Carolina
Smith, D. R. 1965* District of Columbia
Snelling, R. R. 1972 California
Solis, M. A. 1985* District of Columbia
Sollers-Riedel, H. 1938* Virginia
Southard, D. 1994 District of Columbia
Spangler, P. J. 1958* District of Columbia
Spence, J. R. 1986 Alberta
Spilman, R. E. 1950 (1977) Maryland
Spilman, T. J. 1950 (1996) Maryland
Spinelli, G. R. 1983 ARGENTINA
Staines, C. L. 1975 Maryland
Starr, C. K. 1987 TRINIDAD & TOBAGO
Steck, G. J. 1988 Florida
Steinly, B. A. 1983 Illinois
Stewart, R. D. 1985 Maryland
Stibick, J. N. L. 1992* Maryland
Stoetzel, M. B. 1971 Maryland
STONE, A. 1931* (1988) Maryland
Stonedahl, G. M. 1982 ENGLAND
Strickman, D. 1988 SOUTH KOREA
Surdick, R. F. 1979 Virginia
Sutherland, C. M. 1974 New Mexico
Sutherland, D. W. S. 1973* Maryland

Tadauchi, O. 1995 JAPAN
Tennessen, K. J. 1982 Alabama
Thompson, F. C. 1968* District of Columbia
Thompson, J. V. 1953 (1985) New Jersey
Todd, R. G. 1993 Maryland
Togashi, I. 1983* JAPAN
Traub, R. 1947 (1990) Maryland
Triplehorn, C. A. 1972 Ohio
Turner, W. J. 1983 Washington

Ulrich, H. 1978* GERMANY
Utmar, J. 1974* Maryland

Valley, K. 1976 Pennsylvania
Vandenberg, N. J. 1993. District of Columbia
Vazquez, A. W. 1957 Virginia
Vockeroth, J. R. 1995 Ontario
Voegtlin, D. 1981 Illinois
Wagner, D. L. 1994 Connecticut
Wagner, M. R. 1986 Arizona
Wahl, D. B. 1987 Florida
Wallenmaier, T. E. 1979 Michigan
Waller, D. A. 1984 Virginia
Walton, M. 1937 Maryland
Webb, D. W. 1981 Illinois
Weber, N. A. 1941 (1981) Florida
Wenzel, R. L. 1984 Illinois
Wharton, R. A. 1981 Texas
Wheeler, A. G., Jr., 1974 Pennsylvania
White, G. B. 1977* Maryland
Whitsel, R. H. 1967 California
Williams, G. L. 1984 Maryland
Williams, H. B. 1977* District of Columbia
Williams, M. L. 1971 Alabama
Wilson, N. 1957 Iowa
Wojtowicz, J. A. 1981 Tennessee
Woke, P. A. 1936 (1976) Maryland
Wood, D. M. 1987 Ontario
Wood, T. K. 1974 Delaware
Woodley, N. E. 1984* District of Columbia
Woolley, J. B. 1986 Texas

Young, D. K. 1981 Wisconsin

Zack, R. 1982 Washington
Zimmerman, E. C. 1965 AUSTRALIA
Zolnerowich, G. 1987 Texas
Zuccaro, A. E., Jr. 1986 Mississippi
Zungoli, P. 1978 South Carolina
Zuparko, R. L. 1993 California

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1008th Regular Meeting—February 1, 1996

The 1008th Regular Meeting was called to order at 8:07 pm by President Ralph Eckerlin on 1 February 1996 in the Waldo Schmitt Room, National Museum of Natural History, Washington, DC. Sixteen members and three guests were present. The minutes of the December meeting were read by Recording Secretary Darlene Judd. Two corrections were submitted by members and the minutes were accepted as amended. Hollis Williams, Paul Spangler and John Neal were recognized for fulfilling the role of Recording Secretary in the absence of Darlene Judd who had been placed in academic confinement in Texas during the fall 1995.

Darlene Judd, reporting for Membership Chair David Adamski, announced that one new membership application had been received in January for Scott Fitzgerald, Department of Entomology, Colorado State University, Fort Collins, CO.

President-elect M. Alma Solis requested that members submit nominations for speakers of the Spring Banquet.

Ralph Eckerlin discussed the difficulties encountered in contacting officers and members when the government shut-down and the "blizzard of 96" forced cancellation of the January Regular Meeting. As a means of reducing future problems he provided officers with a list of address and telephone numbers and requested that members present include their telephone numbers on the attendance sheet.

The floor was then open for discussion on the proposed changes to the Society bylaws announced at the December meeting. There being no objection to any of the changes suggested by the Bylaws Committee, a motion to accept as presented was made by Wayne Mathis. The motion was seconded by John Neal and the bylaws accepted as proposed. Editor David Smith recommended the new bylaws be published in the July issue of the Proceedings.

Art Borkent (Research Associate of the Royal British Columbia Museum and American Museum of Natural History) and Bill Grogan (University of Maryland, Salisberry) sent a letter expressing gratitude to the Society for providing the financial support and publication of a memoir on *Ceratopogon* (Diptera: Ceratopogonidae).

The untimely passing of two prominent entomologists were announced: George Craig, Jr., University of Notre Dame and William Reed, former President of the Society and retired Army Leutient Colonel.

Program Chair David Furth announced changes in the notification procedures for upcoming meetings that will provide substantial savings to the Society. Future communications will be sent on 8.5 × 11 colored paper rather than the standard 3 × 5 card stock and the list of members receiving the flyer was reduced by one half. Announcements for future meetings of the Society will be sent only to members residing in the Metropolitan area and to those individuals requesting notification.

For notes and exhibitions, Alma Solis showed adult and larval specimens of *Milgithea melanoleuca* Hampson (Pyralidae: Epipaschiinae) reared from *Bixa orellana* in Peru by Guy Coutourier. Photos of damage to the fruits and a diagram of the elongated male antennal scape were also shown. Newspaper articles were contributed by two members. Harry Painter discussed an article on overwintering Monarch butterflies in Mexico where populations suffered a 30% mortality due to inclement weather. Darlene Judd brought an article announcing the opening in February of an exhibit on Insects in Amber at the American Museum of Natural History. Tee shirts that were available for sale at the annual meeting of the

Entomological Society of America were modelled by David Furth.

The speaker for the evening was 1995 President John W. Neal, Jr., Florist and Nursery Plants Research Unit of the National Arboretum, Beltsville, MD. His presentation was entitled "Research on Insects of Ornamental Plants: Diversified Endeavors." Arthropods that are considered pests of ornamental plants characteristically are temporally and spatially discontinuous and highly diverse. As examples, the biology and behavior of four ornamental pests were discussed: *Bemisia tabaci* (sweet potato/silverleaf whitefly), *Synanthedon rododendri* (rhododendron borer), *Thridopteryx ephemeraeformis* (evergreen bagworm) and *Neochlamisus plantani* (sycamore leaf beetle).

One guest, Kevin Holston, interested in *Efferia* Coquillet (Diptera: Asilidae) and on contract with the Systematic Entomology Laboratory, USDA was introduced.

Ralph Eckerlin presented out-going President John Neal with a certificate in appreciation of service to the Society. The meeting was adjourned at 9:14 pm. Refreshments were kindly provided by Bill Bickley.

Respectfully submitted,
Darlene D. Judd, *Recording Secretary*

1009th Regular Meeting—March 7, 1996

The 1009th Regular Meeting was called to order at 8:04 pm by President Ralph Eckerlin on 7 March 1996 in the Waldo Schmitt Room, National Museum of Natural History, Washington, DC. Fifteen members and eight guests were present. The minutes of the February meeting were read by Recording Secretary Darlene Judd. One correction was requested and the minutes were accepted as amended.

Darlene Judd, reporting for Membership Chair David Adamski, announced that one new membership application had been received in February for Ms. Gabriel Mejdalani, Departamento de Zoologia, Universidade Federal do Rio de Janeiro.

Program Chair David Furth announced that the speaker for the March Regular Meeting would be Dr. Gabriela Chavarria from the Museum of Comparative Zoology, Harvard University.

Ralph Eckerlin called for any Old or New Business. There was none and he requested that anyone with notes or exhibitions come forward. Dr. Marion Kotrba brought live specimens of stalk-eyed flies, *Cyrtodiopsis whitei* Curran, a focus of her postdoctoral research.

Dr. Kotrba was also the speaker for the evening. Currently, a Postdoctoral Fellow at the Smithsonian Institution, Washington, DC, her presentation was entitled "Stalk eyes and multi-chambered sperm receptacles in flies: two examples of convergent evolution." She kindly submitted the following abstract for publication in the Society minutes:

> Two examples of convergent evolution in the higher flies (Diptera: Schizophora) were addressed. Stalked eyes occur convergently within 8 schizophoran families (Micropezidae, Diopsidae, Otitidae, Platystomatidae, Tephritidae, Clusiidae, Periscelididae, Drosophilidae), but are scarce in other insect orders (e.g. Hymenoptera: *Aplatoides,* Coleoptera: *Exechesops*). The multiple evolution of stalked eyes in higher flies could have been triggered by the tendency of schizophoran males to engage in territorial combats which often involve spreading of wings and/or legs. Behavioral broadening of the front silhouette might have induced selection for morphological head broadening by stalked eyes or antlers (e.g. *Phytalmia*). Stalked eyes are even subject to two-fold selection as sender and receiver of the signal "eyespan."
>
> The second part of the talk focused on the ventral sperm receptacle. Acalyptrate Schizophora shows extensive variation in form and size of this structure. It ranges

from one-chambered to tubular or multi-chambered, from an inconspicuous pouch to a large and sometimes bizarre vessel. Multi-chambered forms recur within at least 22 of the 64 acalyptrate families. Regarding what is presently known about schizophoran phylogeny, part of these occurrences are due to convergence. Multiple evolution of a multi-chambered ventral receptacle could be the result of selection for separate accommodation of coiled spermatozoa for the process of egg fertilization. Investigation of the female sperm receptacles not only reveals various adaptations to sperm storage and, possibly, female sperm selection. But, through determination of the polarity of character transformation and establishment of the ground plan condition for all families, it will also contribute to the clarification of schizophoran phylogeny.

Three visitors were introduced. Jorge L. Fontenla and Julio A. Genaro from the Museo Nacional Historia Natural, Havana, Cuba and Charles Martin.

The meeting was adjourned at 9:14 pm. Refreshments were kindly provided by Harry Painter.

Respectfully submitted,
Darlene D. Judd, *Recording Secretary*

1010th Regular Meeting—April 4, 1996

The 1010th Regular Meeting was called to order at 8:00 pm by President Ralph Eckerlin on 4 April 1996 in the Waldo Schmitt Room, National Museum of Natural History, Washington, DC. Seventeen members and eleven guests were present. The minutes of the March meeting were accepted as read by Recording Secretary Darlene Judd.

Darlene Judd, reporting for Membership Chair David Adamski, announced that one new membership application had been received in March from Mr. Jerry Cook, Department of Entomology, Texas A&M University, College Station, Texas.

New Business for the Society included a report by Ralph Eckerlin on decisions of the Executive Committee. The Committee voted to move the Spring Banquet, usually held in June, to 15 May 1996 and approved an honorarium of $500.00 for this years speaker.

Program Chair David Furth announced that the speaker for the May Regular Meeting would be Dr. Joachim Adis of the Max Planck Institut für Limnologie, Plön, Germany.

M. Alma Solis, President-elect, submitted a report on the Spring Banquet that was read by David Furth. Dr. May Berenbaum, Professor and Head of the Department of Entomology, University of Illinois, Urbana will be the featured speaker for the evening. Dr. Berenbaum's research on insect-plant interactions has earn her a place in the National Academy of Sciences, and in addition she is the author of several popular books on insects. David Furth will be the Master of Ceremonies. The banquet will be held in the Associates Court, National Museum of Natural History on 15 May 1996. An informal discussion followed the report with concluding remarks by Terry Erwin on X-Files, alien cockroaches, and Bambi Berenbaum.

Ralph Eckerlin called for notes or exhibitions. Following a request by David Furth at a previous meeting, Ed Saugstad and Ralph Eckerlin modelled their entomological T-shirts for the audience. David Smith, Editor of the Proceedings, brought a copy of "The Hymenoptera of Costa Rica," Paul E. Hanson and Ian D. Gauld editors. The book published in 1996 by Oxford University Press contains 138 photographs, 892 illustrations and electron micrographs, and is available at a cost of $265.00.

Dr. Gabriela Chavarria was the speaker for the evening. A recent graduate of Harvard University, her presentation was entitled "Better living with bumble bees: travels, trials, tribulations." She kindly submitted the following abstract for publication in the Society minutes:

A comprehensive comparative morphological, distributional, and behavioral study was performed on Neotropical bumble bees of the genus *Bombus*. Distributed from Mexico to South America, and ranging from sea level up to 4000 meters and possibly higher in the Andean mountain region, bumble bees are primitively eusocial. The group is relatively small consisting of about 250 species worldwide. For the first time, morphological character systems of females were explored and observed to be phylogenetically informative. Comparitive morphological studies focused on the female sting capsule and sixth metasomal sternite. For half of the species, field studies uncovered the nest sites allowing nest architecture to be used as a source of character data. These results provide the first ecological data available on many of the Neotropical bumble bees and provide investigators with critical information useful in making informed comparisons between temperate and tropical species. In addition, evolutionary questions on the origin of tropical bumble bees and the effects of tropical environments can be addressed in a phylogenetic framework. These studies demonstrate that data on behavioral biproducts, such as nest architecture, can provide useful insights into the evolution of this primitively eusocial group.

Two visitors were introduced: Carrie McManaman, University of Maryland, Baltimore Campus and Steve Linafelter, University of Kansas.

Wayne N. Mathis announced that Kevin Holston, a recent visitor on contract with the Systematic Entomology Laboratory, USDA, had been accepted into the doctoral program at the University of Illinois. Mr. Holston's dissertation will focus on the fly family Therevidae and Dr. Mike Erwin will serve as his advisor.

The meeting was adjourned at 9:05 pm. Refreshments were generously provided by David Furth.

Respectfully submitted,
Darlene D. Judd, *Recording Secretary*

1011th Regular Meeting—May 2, 1996

The 1011th Regular Meeting was called to order at 8:02 pm by President Ralph Eckerlin on 2 May 1996 at the National Visitors Center, Beltsville Agricultural Research Center, Beltsville, MD. Seventeen members and eleven guests were present. The minutes of the April meeting were accepted as read by Recording Secretary Darlene Judd.

M. Alma Solis, President-elect, reminded everyone that the Annual Spring Banquet would be held on 15 May 1996 at the Associates Court, National Museum of Natural History, Washington, DC. The speaker for the event is National Academy Member Dr. May Berenbaum from University of Illinois, Urbana. Tickets for the banquet may be purchased from Ray Gagné, Manya Stoetzel, John Neal, Fred Paras, Russ Stewart, John Davidson or Ralph Eckerlin.

David Adamski, Membership Chair, announced that no new membership applications were received in April. There was no new or old business to report.

Ralph Eckerlin called for notes or exhibitions. Dr. Susan Broda-Hydorn, Thysanoptera specialist with USDA, APHIS, brought two drawers of insects that were preserved with taxidermic techniques.

Dr. Joachim Adis was the speaker for the evening. As research scientist with the Tropical Ecology Working Group, Max Planck Institut für Limnologie, Plön, Germany, he gave a presentation on "Diving millipedes and tiger beetles: a lesson from the Amazon." An abstract of the presentation was kindly submitted for publication:

Annual long-term inundation of flood waters for 5–7 months has led to the development of survival strategies in ter-

restrial invertebrates of Central Amazonian floodplains. Several species are amphibious and have active or dormant stages under water. Examples are given for representatives of different orders, in particular for millipedes and tiger beetles. The nature of adaptations found are discussed and compared with those of inhabitants from other tropical and nontropical wetlands.

Four visitors were introduced: David Lamb, John Adamski, Irmgard and Britania Adis.

The meeting was adjourned at 9:12 pm. Refreshments were generously provided by Jill Swearingen and Warren Steiner.

Respectfully submitted,
Darlene D. Judd, *Recording Secretary*

1012th Regular Meeting/Annual Spring Banquet—May 15, 1996

The 1012th Meeting and Annual Spring Banquet was called to order at 7:30 pm by President Ralph Eckerlin on 15 May 1996 at Associates Court, National Museum of Natural History, Washington, DC. The Executive Committee voted to dispense with the reading of the minutes of the 1011th meeting until the September Annual Meeting. President-elect M. Alma Solis announced that Dr. Ray Gagné was again this years top ticket-seller for the Spring Banquet and introduced the Master of Ceremonies David Furth. The speaker for the evening was Dr. May Berenbaum, University of Illinois, Urbana. Dr. Berenbaum delighted and entertained the audience with a presentation entitled "Images of the entomologist—moving or otherwise." A good time was had by all attending the meeting.

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